

# The medical and surgical diseases of John Fitzgerald Kennedy

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## ABSTRACT

**Introduction.** From his first days in public life and his political career, the life of the 35th president of the United States, John Fitzgerald Kennedy (JFK), has generated great interest. His health is also a political subject as, until recently, it was not possible to analyse his medical history in detail. Various specialists, mainly endocrinologists and spinal surgeons, have published reviews on the subject. This article reviews the available medical records of JFK, as well as studies published over the last 50 years addressing his health, the most relevant aspects of his family history, and the published results of his autopsy.

**Objectives.** We present a timeline of the medical and surgical conditions documented by the physicians who treated JFK during his lifetime and discuss the subsequent reviews of his medical history published by contemporary specialists since the 1920s.

**Development.** We summarise JFK's medical history from 1919 to his death in 1963, describing all the known medical and surgical conditions (scarlet fever, whooping cough, colitis, jaundice, duodenal ulcers, irritable bowel syndrome, malaria, prostatitis and urethritis, Addison disease, lumbosacral instability, postoperative abscesses, chronic lumbar pain) and relevant findings from the autopsy performed after his assassination.

**Conclusions.** JFK's health was a known cause of physical limitation during his political career and in his personal life. Despite these limitations, he reached the highest levels in his military and political career, travelled extensively, worked tirelessly, and led an active personal life. His personal and professional development represent the triumph of the patient over chronic disease.

## KEYWORDS

Timeline, lumbar pain, failed back surgery syndrome, adrenal insufficiency, JFK, Kennedy

## Introduction

The life of the 35th president of the United States, John Fitzgerald Kennedy (JFK), from his first days in public life and his political career, has generated great interest due to his charisma, family, and social life. There has been much discussion of his political career, as the youngest elected president of the United States (at the age of 43 years), and his shocking assassination at the

age of 46 years, with much information regarding the assassination remaining secret.

In recent decades, secret reports on parts of JFK's political career have been partially declassified, with documents on his medical history, private travel, and even photographs from his autopsy, performed in 1963 at the National Naval Medical Centre in Bethesda (Maryland, United States), entering the public domain. The last declassification of secret documents was

authorised during the presidency of Donald Trump, in 2017, with the release of an additional 2800 documents, although files containing the most politically relevant information remain classified.

His health was always a subject of public interest and in recent decades it has been possible for American medical specialists and historians to consult his medical records, particularly in the archives of the John F. Kennedy Presidential Library and Museum in Boston (Massachusetts) and the National Archives and Records Administration, although some documents (especially those pertaining to his time in the United States Navy) remain private. His most complete biography was published in 2002 by the historian Robert Dallek, who collaborated with a medical consultant (Dr Jeffrey Kelman) to document JFK's extensive medical history, in addition to his personal and political life.<sup>1-3</sup> In this context, various specialists (mainly endocrinologists and spinal surgeons) have published articles in recent years reviewing some of JFK's better known health conditions, after being authorised to consult his medical records and private documents. The last scientific review was published in 2017 by neurosurgeons from the University of Arkansas; this demonstrates the lasting interest in the figure of JFK, nearly 60 years after his death.<sup>4</sup>

The main aims of this study are to present a timeline of the medical and surgical conditions documented by the physicians who treated JFK during his lifetime, and to discuss the subsequent reviews published by contemporary specialists, from the 1920s to today. As a secondary objective, we include medical opinions of the data analysed in the light of current scientific understanding and review the most relevant elements of JFK's family history, as well as the published autopsy findings. The literature review was performed using the usual sources (PubMed, MESH, and Clinical Key) to identify papers published from the 1950s to 2020. Images were gathered from the archives of the John F. Kennedy Presidential Library and Museum; dissemination of the available images is authorised by the Kennedy family, with no copyright restrictions for publication in most cases.

## Development

The review is divided into five main topics. Firstly, we present the available data on relevant family

history. Secondly, we describe the records of hospital admissions during JFK's childhood and adolescence, based on notes from the biography authorised by his family. Next, we discuss medical records from JFK's professional career, both before and after his election as president of the United States. We then review images and publications regarding his autopsy. Finally, we comment on possible diagnoses based on the available information and today's body of medical knowledge, from our perspective as specialists.

## Medical conditions of the Kennedy family

Information is available on JFK's siblings and children; of nine siblings, four died prematurely. The oldest brother Joseph (1915-1944) died at the age of 29 years in an air accident in the Second World War, when he was piloting a US Navy BQ-8 bomber. During a flight over Suffolk (England), one of the Torpex explosives aboard the aircraft exploded unexpectedly. The second brother, John F. Kennedy (1917-1963), was assassinated at the age of 46 years during his presidency of the United States. He was shot while riding his presidential car during a political visit to Dallas (Texas). JFK's sister Kathleen Agnes (1920-1948) died at the age of 28 years in an air accident, while she and her partner were flying over Ardèche (south France) in a private aircraft. Robert (1925-1968), the eighth-born sibling, was assassinated at the age of 43 years after giving a political speech during the Democrat party primary elections in California.

In the case of Joseph and Kathleen, very few publications exist on their medical histories, as they died very young. However, the story of Rosemary (Rose Marie, 1918-2005), the third-born, has been reviewed extensively due to interest in the outcomes of the lobotomy she underwent at 23 years of age to improve the behavioural alterations she presented. During childhood, she was diagnosed with mild intellectual disability, probably due to perinatal hypoxia. As an adolescent and young adult she developed behavioural alterations, which were treated with what was viewed in the 1940s as a "revolutionary" technique: lobotomy as an experimental treatment for psychiatric disorders.<sup>5</sup> She underwent prefrontal lobotomy in 1941, at the age of 23, and was one of the first patients to be treated with the procedure. She was left with severe cognitive and motor sequelae. Thereafter, she

remained institutionalised in private psychiatric hospitals, and lived to the age of 87 years despite her medical history, eventually dying of pneumonia at Fort Memorial Hospital (Wisconsin, United States) in 2005. The fifth sibling, the sociologist and politician Eunice Mary (1921-2009), dedicated a large part of her life to defending the rights of children and disabled people to healthcare. She presented gastrointestinal problems from the 1940s, but it was not until 1954, at the age of 34 years, that she was diagnosed with Addison disease and began long-term treatment with corticosteroids, which allowed her to reach the age of 88 years, dying due to a stroke. The sixth-born sister, Patricia (1924-2006), was dedicated to art in her youth, and later participated in political life, supporting her brothers; she died from mouth cancer at 82 years of age. The seventh sibling, Jean Ann (1928-2020), lived the longest; a diplomat and humanitarian activist, her prolific political career saw her become the United States ambassador to Ireland. She died recently, at the age of 92; the cause of death has not been specified. Edward, the youngest of the Kennedy children (1932-2009), also dedicated his life to politics from a young age; he died at the age of 77 due to glioblastoma multiforme. His career could have stalled after his involvement in a traffic accident in 1969; his companion in the vehicle died, and he was found guilty of leaving the scene of an accident, which seriously damaged his public image.

From a young age, the four brothers showed absolute dedication to their political careers, aiming to earn military merits before entering politics. JFK was the most distinguished, winning the presidency of the United States in 1960 at the young age of 43 years; this was the family's greatest political achievement. Unfortunately, three of the four brothers saw their political careers cut short by accidents and assassinations. Of the five sisters, three also dedicated their lives to politics, either in their own careers or supporting their brothers in successive presidential campaigns.

JFK had two children with Jacqueline Bouvier: John Fitzgerald Jr. and Caroline. John Fitzgerald Kennedy Jr. ("John-John," 1960-1999) also died prematurely in an aeroplane crash at the age of 39; he was piloting his own aircraft on a private flight with his wife (he had recently obtained his pilot's licence, and his lack of experience was considered the most likely cause of the accident). It was made public knowledge in 2003, after his death,

that he had been diagnosed with Graves disease as an adult, and had been under treatment with Ritalin (methylphenidate) since childhood, suggesting that he had attention-deficit/hyperactivity disorder.<sup>6</sup> His sister Caroline is not known to have had any relevant health conditions.

#### Health conditions during childhood and adolescence

Various publications on JFK's medical history, and especially the biography published in 2002,<sup>1-3</sup> report hospital admissions and medical consultations starting in his childhood. At two years old (1919), he was diagnosed with scarlet fever with torpid progression, which he was able to overcome. At the age of four (1922), he was diagnosed with whooping cough, and between the ages of five and 12 years (1922-1929) he suffered numerous infections, episodes of colitis, asthma attacks and allergies, and rhinitis. Only some of these episodes required hospital admission.<sup>1,2</sup>

At the age of 13 (1930), he presented a first episode of blurred vision in the right eye; no clear diagnosis has been reported. By 14 years old (1931), he had undergone three surgical procedures: tonsillectomy, adenoidectomy, and appendectomy. Gastrointestinal problems persisted throughout his adolescence: at the age of 17 years (1934) he was admitted to the Mayo Clinic in Rochester, subsequently staying several weeks at St Mary's Hospital to be studied due to weight loss, abdominal pain, jaundice, and colitis. He was diagnosed with "spastic colitis" or "peptic ulcer," and in letters to his friends at the time he described his pain and his bad experiences with the gastrointestinal endoscopic techniques of the day.<sup>1-3</sup> The treatments he received included specific diets of rice, wheat, and potatoes, and even parathyroid hormone serums derived from animals. He presented episodes of jaundice at the ages of 18 (1935) and 19 years (1936); in the latter episode, "possible leukaemia" was also suspected due to reduced white blood cell count observed in different studies performed in the months prior. The episode was eventually attributed to immunosuppression secondary to the different pharmacological treatments used to treat colitis. This seems the most likely diagnosis, as photographs from six months later show JFK posing aboard a yacht.

At the age of 20-21 years (1937-1938), when he was studying at Harvard University, he began to

present urinary tract infections in addition to the chronic gastrointestinal problems. He was diagnosed with gonorrhoea and chlamydia and was treated with penicillin and sulfamides. He subsequently presented several episodes of prostatitis and recurrent urethritis during his university years.<sup>7</sup> In 1937, deoxycorticosterone acetate began to be used to treat certain inflammatory diseases, including “spastic colitis,” which JFK presented. At the time, it was administered as a small subcutaneous implant; JFK seems to have used corticosteroid treatments from their discovery until 1949, when synthetic corticosteroids became available; his Addison disease had not yet officially been diagnosed.

These problems did not prevent him from participating in the university’s American football and swimming teams during his first year of study. However, he developed sacroiliac pain in 1938; this persisted throughout his lifetime.

#### Health conditions during adulthood

The first time lumbar pain was mentioned in his medical records was in 1937-1940, when he was just 20 years old. During his early years at Harvard University, JFK began presenting episodes of lumbar pain, which became worse until 1940, when he experienced intense, apparently post-traumatic pain (according to JFK, it began after a sudden movement during a tennis game, as reflected in the biography by Dallek; his mother considered that it occurred after playing American football, as recorded in notes from Charleston Naval Hospital).<sup>8</sup>

In 1940, after graduating from Harvard at the age of 23, he consulted a traumatologist specialising in spinal conditions (Dr Gilbert Haggart), who diagnosed him with lumbosacral instability secondary to sporting injuries (he played American football at university) and recommended conservative treatment. Kennedy attended the Lahey and Mayo clinics for a second opinion. Both centres suggested lumbar and sacroiliac joint fusion.

In 1942, he continued consulting with various specialists due to persistent lumbar pain. This time, he saw the traumatologist Dr Marius Smith-Petersen, who rejected the suggestion of surgical treatment; in notes sent to another colleague (Dr James White, a Navy



**Figure 1.** Enlisted in the United States Navy in 1942, John F. Kennedy was posted to the Pacific Ocean as commanding officer of a torpedo boat. John F. Kennedy Presidential Library and Museum (jfklibrary.org).

neurosurgeon) he explained that, given the progression of the pain and the presence of normal reflexes, he considered neurological assessment more advisable.<sup>8</sup>

In 1943, with the lumbar pain persisting, JFK enlisted in the United States Navy and was posted to the Pacific Ocean as commanding officer of a torpedo boat, at the height of the Second World War (Figure 1). The boat was sunk by the Japanese destroyer *Amagiri*, and Kennedy swam for five hours alongside his men to an island three miles away; this seems to have worsened his lumbar pain, although he earned the Navy and Marine Corps medal. In addition to the lumbar back pain, he also presented episodes of colitis, urine infections, and malaria during his time posted in the Pacific.

In 1944, back in the United States after his service in the war, he again consulted various physicians due to worsening of his lower back problems. After being assessed by multiple specialists, in June 1944 (27 years old) he finally underwent L4-L5 hemilaminectomy and L5-S1 discectomy; the procedures were performed by Dr James Poppen of the Lahey Clinic. However, the surgeon himself was surprised by the poor postoperative progression, with intense pain and muscle spasms disproportionate to the type of surgery.<sup>8</sup> Due to this poor recovery, he was re-evaluated by Dr



James White in August 1944. Other spinal surgery specialists (Dr R. Hart, Dr Pait, and Dr Dowdy) who have subsequently consulted these reports note that they were unable to view radiography images obtained before this first surgery (the images could not be located, although the notes do mention that the study was performed).<sup>4,8</sup> Also in 1944, the gastroenterologist Sara Jordan of the Lahey Clinic in Boston reviewed JFK's medical records from the Mayo Clinic and from her own centre, confirming that JFK had been diagnosed with "diffuse duodenitis and severe spastic colitis" during the years of hospital admissions in his youth.

In 1945 (aged 28), JFK retired from his naval career, after the lumbar spinal surgery and persisting episodes of colitis, with which he had suffered since adolescence. In 1946, shortly after his discharge from the armed forces, he launched his political career; he presented chronic lumbar pain and had been treated with a first surgical procedure, with limited results.

In 1947, after his 30th birthday, he was officially diagnosed with adrenal insufficiency (a disease first described by Thomas Addison in 1855, subsequently reported as part of autoimmune polyglandular syndrome type 1 by the German physician Martin Benno Schmidt in 1926 and autoimmune polyglandular syndrome type 2 in 1980).<sup>9</sup> In 1947, Dr Edward Kendall (1886-1972) of the Mayo Clinic succeeded in isolating a new purified compound from extracts from the adrenal gland, which he named cortisone; the substance began to be used in the treatment of rheumatoid arthritis. The treatment was initially administered parenterally; the same year it was discovered, JFK was diagnosed with Addison disease, although he probably already had the disease at the age of 17-18 years, when he was admitted due to jaundice and colitis.<sup>9-11</sup> He began receiving treatment with parenteral cortisone, and subsequently started receiving the drug orally after Kuch (University of Chicago) and Kendall worked with different pharmaceutical laboratories to create the oral form, and synthetic corticosteroids (available in 1949), which JFK received until his death.

The episodes of colitis and asthenia seem to have stabilised by 1954 (aged 37 years), ten years after his first spinal surgery, but he continued presenting lumbar pain despite medical and rehabilitation treatments. This motivated the decision to undergo a second

surgery. This time, the procedure was performed by the renowned traumatologist and orthopaedist Dr Philip Wilson of Harvard University, who had patented the Wilson plate for lumbosacral fusion, the technique of choice for JFK. Surgeons who have been able to review the preoperative studies (mainly radiography and myelography studies) observed loss of disc height of approximately 70% at L5-S1, with anterior osteophytes but no evidence of osteoporosis or vertebral fractures, despite the patient having taken corticosteroids for seven years at that time.<sup>4,8</sup> Only the biography by Robert Dallek mentions a possible compressive fracture, although this is not corroborated in subsequent reviews published in 2006 and 2017.<sup>1,2,4,8</sup> In their 2017 review, Pait and Dowdy<sup>4</sup> suggest that the pain was multifactorial: mechanical, due to instability of the sacroiliac joints, and secondary to the reoperated lumbar fusion (this may be compatible with the current concept of "failed back surgery syndrome," coined by Dr Hart in 2006). The authors also note that JFK's situation presented features that are common in today's clinical practice: the potential issue of "VIP care," and the multiple opinions of experts from the different clinics he visited. "VIP care" or preferential treatment for famous people and acquaintances or relatives of important members of the community (in the political, social, artistic spheres, etc) can be more a hindrance than a help in the diagnosis and treatment of a patient ("recommendations end poorly").

Between 1954 and 1955 (37-38 years of age), the documents reviewed describe a complex postoperative period with persistent pain, infections, and episodes of adrenal crisis, which were also reported internationally.

In 1955 (38 years of age), a supposedly anonymised report described JFK's progression following the second spinal surgery.<sup>12</sup> The article, entitled "Management of adrenocortical insufficiency during surgery," reported the cases of three patients undergoing surgery for different reasons; it was leaked that the third patient was JFK. The article described the corticotherapy he was receiving, the anaesthetics and analgesics used, and the postoperative complications (particularly another urine infection and angioedema as an adverse reaction to blood transfusion).<sup>12</sup> Postoperative radiography images show correct fusion of the left sacroiliac joints and the L5-S1 vertebrae. Several weeks later, he returned to the operating



**Figure 2.** June 1961: National Conference on International Economic and Social Development. John F. Kennedy Presidential Library and Museum (jfklibrary.org).

theatre (third surgery) due to instability and infection of the instrumentation. No further radiography images are available after this third procedure.<sup>4,8</sup>

Notes from New York Hospital, reported by Dr Janet Travell, describe how Kennedy was diagnosed with hypothyroidism and possible hypogonadism in 1955.<sup>10</sup>

In 1957 (40 years old), JFK had to undergo spinal surgery for the fourth and final time; this time it was essential, due to a superficial abscess colonised by *Staphylococcus aureus* at the L4-L5 level. On this occasion, the procedure was performed by a general surgeon (Dr Preston Wade).

Between 1958 and his death in 1963, JFK only received conservative treatment, and no further surgical

procedures were indicated. Pain was treated with a range of narcotics, braces, physiotherapy, procaine injections, and intravenous methamphetamines. The John F. Kennedy residential Library and Museum (<https://www.jfklibrary.org/>) holds multiple family photographs, showing JFK wearing the lumbar brace of the time, and the crutches he used after his surgical procedures (Figure 2). The brace he was wearing on the day of his assassination (Figure 3) is also shown in the FBI archive at the National Archives. The famous words of his brother Robert, “At least, half the days he spent on this Earth were days of intense physical pain,” summarise the extensive medical history of JFK’s 46 years.



**Figure 3.** Images of the brace that John F. Kennedy was wearing on the day of his assassination (FBI Archives).

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During Kennedy's 1960 presidential campaign (aged 43), his diagnosis of Addison disease was made public by his political rivals, who hoped to influence the result of the elections by discrediting him based on his chronic disease. However, this was unsuccessful, and he was victorious in that year's presidential elections, becoming America's youngest president elect, at 43 years of age.

According to the notes of Dr Janet Travell, in 1961 (aged 44), Kennedy was under treatment with ascorbic acid, hydrocortisone, prednisone, methyltestosterone, tyrosine, and epinephrine.<sup>10,13,14</sup> This treatment enabled him to continue leading an active professional life, and he also used crutches or his back brace during public events. His famous rocking chair, where he sat when he received politicians and other important visitors at the White House (Figure 4), helped him to tolerate his

back pain and the discomfort of his brace. As a chronic patient, he was able to develop his political career from 1960 to 1963, the year he was assassinated.

#### Autopsy study

Kennedy was assassinated on 22 November 1963, shot while he and his wife were riding in a convertible car during a political event in Texas. After the assassination, his successor as president, Lyndon B. Johnson, established a presidential commission to investigate the facts, mainly aiming to establish the cause of death and the identity of the assassin. The commission (also called the Warren Commission, after its chairman, Chief Justice Earl Warren) examined the results of forensic studies, as well as evaluating police reports, political documents, and the theories of the investigators. The commission's conclusions were



published in the famous Warren Report in September 1964.<sup>15</sup> The document was strongly criticised at the time, as it failed to clarify numerous details of the assassination, favouring the emergence of conspiracy theories about who had truly assassinated Kennedy.

According to the medical documents available in the report, JFK was shot on the streets of Dallas and directly transferred to Trauma Room 1 at Parkland Memorial Hospital in Dallas. The first physicians to attend him (already dying) were two general surgery residents (Dr James Carrico and Dr Ron Jones) and a thoracic-vascular surgery resident (Dr Malcolm Perry), who attempted to keep him haemodynamically stable, with the aid of several anaesthetists.<sup>16,17</sup> The head wounds were evaluated by Dr Robert G. Grossman, who had recently completed his neurosurgery residency at the Neurological Institute of New York. His detailed eyewitness account of the events can be consulted in previous publications.<sup>16,17</sup> Grossman described how when the president arrived, the physicians identified a wound on the lower third of the anterior neck (supraclavicular) and a large gunshot wound in the right posterior parietal area, with loss of brain mass, bone tissue, and a large quantity of blood; pupils were non-reactive.<sup>16</sup> Another parietofrontal wound appeared to be the exit wound. Dr Kemp Clark, head of neurosurgery at the centre, also evaluated the president soon after his arrival at hospital, and pronounced the time of death. The official autopsy was performed the same day at the National Naval Medical Centre in Bethesda. The procedure was conducted by three Navy pathologists: Dr James J. Humes, Dr J. Thornton Boswell, and Dr Pierre A. Finck.<sup>17,18</sup> The study included an anteroposterior and two lateral head radiographies and a detailed description of the head wounds, establishing the trajectory of the bullet and confirming the cause of death.<sup>19</sup>

All medical photographs from the autopsy were taken by John Thomas Stringer Jr. and Floyd Albert Riebe. These images have been reviewed over the years by numerous physicians, lawyers, and politicians. They were initially held by the United States Secret Service, and subsequently at the National Archives, where all information pertaining to the Warren Report is registered. Since the latest declassification of documents related to the death of JFK, some photographs can be accessed with the main Internet search engines. One



**Figure 4.** John F. Kennedy in his rocking chair in the White House Oval Office, receiving the astronaut John H. Glenn Jr. Washington D.C., 1962. John F. Kennedy Presidential Library and Museum ([jfklibrary.org](http://jfklibrary.org)).

such image shows an extensive scar over the thoracic-lumbar spine, a sequela of the surgical procedures described above, and the wound from one of the bullets that hit him (Figure 5).

The reports on the autopsy images and tests are controversial: several photographs do not include scale bars, making it impossible to accurately calculate the size of the wounds; the radiological study was incomplete; and autopsy images are of low quality. Furthermore, there was suspicion that some images disappeared during the review process.<sup>19</sup> As a result, the autopsy and its conclusions were always subject to scrutiny.<sup>20,21</sup> Although the Kennedy family had authorised a complete, comprehensive autopsy study, the study was considered for years only to have been partial, perhaps due to the pressure of working with the Secret Service or military police. Questions were even raised about the experience of the pathologists responsible for the study, and the experience in treating gunshot wounds of the first physicians to attend the president at Parkland Memorial Hospital. The





**Figure 5.** Images from the autopsy performed at the National Naval Medical Centre in Bethesda (Maryland, United States) on 22 November 1963. The image shows a paravertebral gunshot wound to the right of the T1 vertebra and an extensive scar over the thoracic-lumbar column.

Warren Report concluded that the president was shot three times, although there were only two clear bullet wounds: one passing beside the thoracic spine at the T1 level, above the right scapula (which was not described by the neurosurgeons who attended him), with an exit wound in the right paratracheal region (Figure 5), and another that struck the right parieto-occipital region and exited in the right frontal region, causing extensive damage to the right cerebral hemisphere, considered the final cause of death.<sup>15</sup>

With the controversy surrounding the Warren Report and its conclusions about the number of shots, the trajectories of the bullets, and the possible identity of the assassin, the subject of the autopsy was also questioned over the following years, to the extent that

multiple subsequent reviews were published by different medical and legal professionals.<sup>22,23</sup> The second relevant review of the autopsy report was conducted by the Attorney General Ramsey Clark in 1968, and included photographs and radiography images from the autopsy; the third detailed review was conducted between 1972 and 1980 by Dr John K. Lattimer, a urologist at Columbia University. Lattimer was able to review all the documentation on the autopsy and to perform his own ballistics testing, with the authorisation of the Kennedy family, to confirm whether Kennedy was shot two or three times, and published his own theories.<sup>24-26</sup> We should also emphasise the impact of this subject in Spain; Dr José Luís Romero<sup>27</sup> published an interesting doctoral thesis on JFK's autopsy in 1992.

While the trajectories of the bullets are extensively and accurately discussed in the Warren Commission's autopsy report, the poor description of the rest of the body is noteworthy. According to the official reports available on the autopsy,<sup>19,27</sup> macroscopic examination identified an abdominal scar approximately 8 cm long, probably from one of the president's abdominal surgeries (perhaps appendectomy). Another post-surgical scar, measuring 15 cm, was observed over the lumbar spine (Figure 5). The thoracic organs are described as normal, without pleural effusion; no alterations are reported in the heart and lungs. In the analysis of the abdominal cavity, the authors note the absence of the appendix, as well as several adhesions near the scar, but no other relevant findings. The skeleton is described as normal overall, with no discussion of individual bones; while the president was known to have undergone spinal surgery, no details of this are given. In the microscopy study, the heart, lungs, liver, spleen, kidneys, and skin were normal, with the exception of the areas near the gunshot wounds.<sup>27</sup> The report mentions that radiography images were taken of the whole body, but that these were delivered directly to the Secret Service; surprisingly, they are not included in the autopsy report. The lack of discussion of the adrenal glands is also striking, given the publicity surrounding his diagnosis of Addison disease during the electoral campaign. It is also very noteworthy that no data is provided on the pituitary gland, spinal column, or sacroiliac joints, either due to direct omission from the study, for unknown reasons, or because part of the autopsy documentation was lost after being held by different administrative bodies.<sup>19,27</sup>

Subsequently, in the 1972 review, Lattimer studied the radiography images of the area of the adrenal glands, noting the absence of abnormal calcification of the area, which would have been suggestive of tuberculosis; therefore, he suggests that JFK presented idiopathic bilateral adrenal atrophy. He also reviewed radiography images of the lumbar spine, which showed an L5-S1 fusion, metal lumbar fusion plates, and the presence and good differentiation of the anatomy of the lumbar vertebrae.<sup>24-26</sup>

### Post-mortem diagnostic hypotheses

Until his assassination in 1963, JFK presented several diseases with clear diagnoses and others about which we may only hypothesise based on the symptoms described, the treatments received, and the available autopsy findings.

The most widespread medical hypothesis concerns his history of endocrine conditions. Autoimmune polyglandular syndrome type 2 was described for the first time in 1980 (the condition mainly affects men aged 20-40 years and presents with primary adrenal insufficiency and autoimmune thyroiditis, sometimes associated with hypogonadism, coeliac disease, and pernicious anaemia); this disease would seem to explain practically all the symptoms that Kennedy presented several years earlier, as several endocrinologists have recently suggested.<sup>28</sup> Furthermore, both JFK and his sister Eunice were diagnosed with Addison disease. The president's son was also diagnosed with Graves disease; therefore, hereditary autoimmune disease seems very likely.

The second very probable hypothesis is "failed back surgery syndrome," given the persistent chronic lumbar pain after several surgical procedures and associated complications; this diagnosis is also appropriate, in our opinion.<sup>8</sup>

In the light of the available data, and with a view to attributing all his symptoms to clinical entities that are currently recognised, what other, less probable, diseases might he also have had, that could not be diagnosed at the time?

The possibility of ankylosing spondylitis seems realistic: this is a form of adult-onset arthritis, predominantly presenting in men, which mainly affects the lumbosacral spine and sacroiliac joints.<sup>29</sup> In

addition to joint and lumbar back pain, it may present with episodes of uveitis, and JFK presented an initial episode of unilateral blurred vision at the age of 13 years, although the gastrointestinal symptoms that he presented throughout his life would not be clearly related to this entity.

Adrenoleukodystrophy seems less likely, although it would account for many of the symptoms that JFK presented during his life: the disorder predominantly occurs in men, and the less severe form presents with adrenal insufficiency in 70% of cases (this may be the only manifestation for years), and is also associated with hypogonadism.<sup>30</sup> It can progress to paraparesis with spasticity, although JFK did not present this clinical situation before his death; such imaging techniques as MRI (developed in the late 1970s) were not available at the time to corroborate this theory.

Another possible diagnosis is lumbar spondyloarthritis, which is very common in the general population, and may be triggered by sport: JFK was a keen sportsman during his university years, and underwent surgical procedures for lumbar back problems from a young age.<sup>31</sup> However, the absence of clear discopathy in the radiography images obtained after the first lumbar procedure (preoperative images could not be assessed) and the persistence of chronic pain despite the numerous treatments prescribed seem to contradict this diagnosis.

The lack of clear osteopaenia or osteoporosis of the spine and sacrum in a patient who used corticosteroids for more than 20 years is also surprising, although these symptoms are not apparent in any of the radiographs reviewed by different spinal surgeons.

He may also have presented coeliac disease, with symptoms of diarrhoea and osteoporosis, although he did not fulfil such other criteria as rickets or family history of the condition.<sup>32</sup> Severe, persistent spastic colitis may also be related to irritable bowel syndrome, Crohn disease, or ulcerative colitis, although the findings from colonoscopy procedures at the time (straight tubes that analysed the last 30 cm of the intestine) appear inconclusive.<sup>33</sup> Peptic ulcers most frequently affect the stomach or duodenum, with the rectum and terminal colon usually being unaffected.

Tabes dorsalis (a late complication of syphilis, with involvement of the meninges and dorsal columns and

roots, which causes thoracic-lumbar pain, tabetic gait secondary to loss of proprioception, skin lesions, and generalised arthrosis) is another possible explanation for JFK's symptoms. However, the reviews available report chlamydia and gonorrhoea infections, but not syphilis.<sup>7</sup>

Unfortunately, these potential diagnoses could not be confirmed, as some of today's diagnostic techniques, such as brain and spinal MRI, or antibody determination in autoimmune diseases, were not available in the 1950s and 1960s. Access to a more complete report of the autopsy may be helpful in ruling out various possible diagnoses that currently cannot be verified.

## Conclusions

JFK's health was a known cause of physical limitation during his political career and in his personal life. Despite his poor health, his military and political career reached the highest levels and he travelled extensively, worked tirelessly, and led an active personal life. His personal and professional development represent the triumph of the patient over chronic disease.

## Conflicts of interest

The authors have no conflicts of interest to declare and have approved the content of the manuscript. This is an original text and has not been submitted for assessment at any other journal. The data were presented at the Annual Meeting of the Spanish Society of Neurology in 2018. None of the authors has received partial or total funding from any pharmaceutical company or any other organisation for this article.

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