showed him, and we crossed the street and on the edge of the curb, along Main Street, we found the bullet mark. And it lined right up with the Texas School Book Depository."[32] A fragment had struck the curb, sending a chip of concrete into Tague's cheek. When asked which shot hit the curb, Tague says, "I actually can't tell you which one. I could try to pick one, but through the years I have maintained accuracy. I don't know which one hit me."[33]

Although Dallas newspapers prominently reported Tague's injury, the FBI and Warren Commission initially ignored him. The Commission did not talk to him until July 1964, and the FBI did not even get a sample of the curbstone until that late date.[34] The Warren Commission concluded, "The mark on the south curb of Main Street cannot be identified conclusively with any of the three shots fired. Under the circumstances it might have come from the bullet which hit the President's head, or it might have been a product of fragmentation of the missed shot upon hitting some other object in the area."[35]

The Commission's guess that a fragment from the head wound might have caused the curb damage is not realistic. Two large fragments were found in the front of the President's car, one weighing 44.6 grams, and the other 21.0 grams (about a quarter and an eighth of the whole bullet).[36] Smaller lead fragments were found under the carpet and near the front seat. However, those fragments were so spent from the tremendous force expended on Kennedy's head wound that all they did inside the car was crack the windshield and dent a chrome strip. They did not penetrate any of the leather seats or the dashboard or cause any other damage to the car or its occupants. It is highly unlikely that any fragment from the head shot would have enough energy left to travel another 260 feet and knock a chip off a concrete curb.

There is a much simpler explanation of how Tague was wounded, and it resolves the issue of what happened to the missed first shot. Only a bullet fragment hit the concrete near Tague, since when the FBI later performed a spectrographic analysis on the curb, it showed "traces of lead with a trace of antimony."[37] The 6.5mm bullets used in Oswald's gun had full copper jackets (a metal covering on a bullet, designed to increase its pen-

etration). Since there was no copper found on the curb, it meant the fragment that struck was not jacketed. Agent Lyndal Shaneyfelt testified that the lead instead came from the bullet's core.

Art Pence, a competition firearms expert, told the author, "If a 6.5mm bullet struck a hard tree branch, it could tear itself apart by its own rotational speed. It would then fragment, with maybe the largest fragment, the tip, being up to one third of the bullet, flying off. And if the tree was oak"—it was—"it has tremendous compressive strength, and the wood could easily suffer less damage than the bullet that hit it.

"When the lead core separates from the jacket, the core fragment is compact, and more aerodynamically stable, and tends to follow a straight course, whereas the jacket is light and will be very destabilized."[38]*

What is likely is that after the bullet fragmented against a tree branch, the stable lead core remained in a straight line from the Depository and struck the curb, over five hundered feet away. The destabilized copper jacket hit the pavement, giving Virgie Rachley the impression of sparks. Neither fragment was ever recovered.**

If the first shot was near frame 160 and the third one at 313, when was the middle shot? And was it possible for that second bullet to have caused both the President's neck wound and all the governor's wounds, the so-called "single-bullet theory"?

On an unenhanced version of the Zapruder film, when the presidential car emerges from behind the road sign at frame 225, President Kennedy's right arm appears to be rising in response to a bullet wound. Governor Connally does not appear to show any reaction to his wounds until his mouth opens at frame 235. That

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*When Dr. John Lattimer performed shooting experiments with the same 6.5mm ammunition as that used by Oswald, he discovered that the lead core "often" separated from the jacket.

**There is a photograph of deputy sheriff Buddy Walthers, crouching over a manhole cover in Dealey Plaza, and this led to speculation that another bullet was found. But Walthers denied he ever found or saw any bullet fragment. What he did find was a small bone fragment, part of the President's skull (Sheriff Jim Bowles, interviewed by author, March 1992; Gus Rose, interviewed by Earl Golz, undated).

15. Ibid., p. 754.
16. Ibid., p. 760.
17. Interview with Jim Moore, March 9, 1992.
18. David Lui, "The Little Girl Must Have Heard," *The Dallas Times Herald,* June 3, 1979, H-3.
19. Rosemary Willis interview with Marcia Smith-Durk, 1979.
20. Testimony of John B. Connally, WC Vol. IV, pp. 132–33.
21. HSCA Vol. VI, p. 29.
22. Luis Alvarez, "A Physicist Examines the Kennedy Assassination Film," *American Journal of Physics,* Vol. 44, No. 9, September 1976, pp. 815–19.
23. "The Warren Report," CBS News, Part I, June 25, 1967, pp. 17–18.
24. Ibid., p. 29.
25. Ibid., p. 28.
26. Testimony of Dr. Vincent Guinn, HSCA Vol. I, pp. 504, 555–56.
27. Testimony of Robert Frazier, WC Vol. V, pp. 172–73.
28. Interview with Robert Kraus, March 29, 1992.
29. Testimony of Virgie Rachley, WC Vol. VII, p. 509.
30. Ibid., p. 513.
31. Interview with James Tague, January 19, 1992.
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34. Warren Commission memorandum, Arlen Specter to Lee Rankin, June 11, 1964; WC Vol. XXI, p. 472.
35. WR, p. 117.
36. Testimony of Robert Frazier, WC Vol. III, pp. 432, 435.
37. Testimony of Lyndal Shaneyfelt, WC Vol. XV, p. 700.
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39. WR, p. 105.
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45. Testimony of Dr. Malcolm Perry, WC Vol. III, p. 389; Lattimer, *Kennedy and Lincoln,* pp. 241–43;
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48. Lattimer, op. cit., pp. 243–44; interview with Dr. Lattimer, February 6, 1992.
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difference of ten frames is just over half a second between the reactions of the two men. However, the Warren Commission was unable to pinpoint the exact frame at which the President and the Governor were hit, instead giving only a range from frames 210 to 225.[39] Conspiracy critics used the earliest possible time, frame 210, and then argued that since Connally did not show a clear reaction until frame 235 (a difference of 25 frames, or 1.4 seconds) his reaction was too slow for him to have been hit by the same bullet that hit Kennedy. If Connally was hit by another bullet, it had to be fired from a second shooter, since the Warren Commission's own reconstructions showed that Oswald could not have operated the bolt and refired in 1.4 seconds. The House Select Committee came to different conclusions, but it did not eliminate the timing problem. It actually increased the time between the moment it said Kennedy was wounded (frame 190) and the moment it saw a marked difference in Connally's posture and facial expressions (frame 226).[40] If the same bullet struck both men, the Select Committee's difference of 36 frames meant the Governor sat unfazed in his seat for nearly two seconds after being wounded.[41] The Warren Commission and Select Committee both explained the delay in Connally's reaction by citing many examples of gunshot victims who had slow reactions and sometimes did not even know they were hit by a bullet. They pointed out that Connally admitted he did not know about his wrist and thigh wounds until the following day.[42] However, both government panels ignored his clear testimony about instantly feeling the impact of the bullet in his right rear shoulder. "It felt like someone had hit me in the back," he recalled. "I knew I had been hit, and I immediately assumed, because of the amount of blood, and, in fact, that it had obviously passed through my chest, that I had probably been fatally hit . . ."[43]

The confusion over the exact timing of the second shot and whether there was an unreasonably delayed reaction by Connally might never have been resolved if further enhancements of the Zapruder film had not become available in 1992. The latest enhancements show that before the President disappeared behind the sign at frame 200, he was waving to the crowd with his right hand. Even when the car and his body are obscured by the road

sign, the top of his right hand can sometimes be seen waving. By frame 224, half the car is back in view. The Governor has also emerged and is fully visible, but all that can be seen of the President is his right hand. It is only a few inches above the doorframe. In Zapruder frame 225, the President is almost in full view and his hand is lower, with the elbow resting on the edge of the car. He was bringing it down from a wave. By 226, Kennedy started raising his arm again. At 227, the President's elbow jerked off the car. He was in full reaction to the bullet that hit him from the rear and exited his throat.

Working backward from JFK's reaction, it is possible to pinpoint the precise time of the second shot. The Warren Commission was not aware that the President's spine was damaged by the bullet that entered the base of his neck, since the autopsy physicians did not examine the spine and did not use the X rays in preparing their final report.[44] The damage was first discovered by Dr. John Lattimer when he examined the autopsy X rays in 1972. The bullet passed so close to the spine that it caused "blast injury," trauma near the sixth cervical vertabra, C-6 (in the vicinity of the tip of the transverse process).[45] On the X rays there are small splinters of bone at the point of trauma. The bullet did not even have to hit the spine to cause such an injury—entering the body at more than 2,000 feet per second and traversing very close would be enough.[46] "The bullet creates a cavity in soft tissue as it passes, and the shock traumatizes the spinal cord," says Dr. Lattimer.[47]

A spinal injury at the level of C-6 is significant because it can cause an instantaneous reaction called "Thorburn's Position."[48] Named after the English physician who discovered it over a hundred years ago, it refers to spinal injury that forces the victim's arms to jerk up into a fixed position, almost parallel with the chin, the hands gathered near the chin and the elbows pushed out to the sides.[49] That is exactly the position the President started assuming at frames 226–227.

Most observers of the Zapruder film, as well as eyewitnesses that day, incorrectly thought the President was grabbing at his throat in response to the bullet that struck him. But the Thorburn Position is a neurological reflex, and upon examination of the enhanced film one can see that the President's hands never

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touch his throat. Moreover, once C-6 is damaged, the arms would have remained locked in the raised position indefinitely—except the destruction of the right hemisphere of JFK's brain by the head shot released the position. Any doubt he suffered the Thorburn damage to C-6 is resolved in the Zapruder enhancement. In the nearly five seconds that elapsed between the neck and head wound, Mrs. Kennedy leaned over toward him to see what had happened. At one point, she grabbed his raised left arm with her right hand and tried to push it down. It stayed up. Then she reached with both hands and tried again to push it down, but the film clearly records his resistance. His arm did not lower.

Kennedy's Thorburn response, from spinal damage, at frames 226–227, came between one tenth and two tenths of a second after the bullet hit him, which translates to 1.8 to 3.66 Zapruder frames.[50] That means President Kennedy was first wounded at frames 223–224, or just before he was visible from behind the road sign. That is 3.5 seconds after Oswald had fired his first shot near frame 160, more than enough time for him to cock the bolt, re-aim, and fire again.

The focus now moves to Governor Connally. When does he show evidence of being shot? Is there a long enough delay to raise the possibility that a separate bullet, from a second gunman, struck him?

Watching the Zapruder film at its normal speed, or looking at photographs of still frames, provides a misleading impression of when the Governor was hit. Prior to his Warren Commission testimony, the Governor examined the Zapruder film and felt he was struck between frames 231–234 (just before he opened his mouth at frame 235).[51] Mrs. Connally also studied the film before her testimony and thought her husband was hit between 229–233. Two and a half years later, the Governor examined four-by-five-inch transparencies, and after several hours still felt he was hit at frame 234.

The enhanced film shows several physical reactions that reveal exactly when the Governor was hit, and it is within a half second of when he and his wife originally thought the shot struck. At 224, the right front of the Governor's suit lapel flips up from his chest. Discovered in a 1992 computer enhancement by Jeff Lotz

of Failure Analysis Associates, this jacket movement may be one of the most important timing confirmations in the case, as it established the moment the bullet hit him. The movement of the jacket took place at the exact area where the Governor's suit and shirt have a bullet hole, as the missile passed through his right shoulder blade and out under his right nipple.[52]

Since Kennedy and Connally were less than two feet apart in the car, the bullet, with an initial muzzle velocity of more than 2,000 feet per second, passed through them almost simultaneously, at frame 224. Beyond the movement of Connally's suit jacket and the Select Committee's finding that he changed his expression and became rigid at 226, there is other evidence he was struck at this point.[53] A film enhancement of that same frame, done by Dr. Michael West, shows that the Governor's light-colored Stetson hat, which he was holding in his right hand, near his chest, started rising. It flipped quickly up during frames 227 and 228 and then at 229 it started coming down rapidly, and by the next frame it was at its original position. That violent reaction with the governor's hat took less than one third of a second. According to Dr. West, it is "positive proof" of a neurological reaction to physical trauma.[54]*

"It took only an instant for the bullet to pass through Connally's chest, then strike his wrist, and finally settle in his leg," says Dr. West. "His chest wound gave him a pneumothorax [a punctured lung]. When he took his next breath, his lung collapsed, and that is a very painful situation. It sends a nerve signal to the brain's cortex, which in turn will send out his pain transmitters, all in an instant. But the Governor had to take his next full breath after the bullet passed his chest, before all hell broke loose for him."[55]

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*The critics have long charged that the Governor held on to his hat during these frames—proof, they claim, that his wrist could not have been wounded at that point. "If he doesn't drop the hat, it doesn't mean a thing," says Dr. Michael Baden. "Some say that the Governor's radial nerve was damaged, but that's not true. There was no radial damage, but even if that nerve had been hit, he wouldn't have dropped it. His wrist was clearly wounded, with the radius bone broken. No one argues that." Baden says it is a "moot point," since the Zapruder film never shows him dropping the hat.

ernor was still turning back to his original position, just as he recalled, at frame 224.

Talking of the bullet that wounded him, Connally told the Warren Commission: "Well, in my judgment, it just couldn't be the first one because I heard the sound of the shot. In the first place, I don't know anything about the velocity of this particular bullet, but any rifle has a velocity that exceeds the speed of sound, and when I heard the sound of that first shot, that bullet had already reached where I was, or it had reached that far, and after I heard that shot . . . I started to turn to my left before I felt anything. It is not conceivable to me that I could have been hit by the first bullet, and I felt the blow from something which was obviously a bullet, which I assumed was a bullet, and I never heard the second shot, didn't hear it. I didn't hear but two shots. I think I heard the first shot and the third shot."[58]

The Governor's explanation is sound. Doctors familiar with gunshot wounds say it is normal for the shock caused by the wound to block the sound from the victim.[59] Yet the Warren Commission still decided that the first bullet most likely hit Kennedy and Connally. The Governor, who had described a "very, very brief span of time" between the first shot and the one that hit him, knew that was impossible. While he accepted the Commission's conclusions about Oswald being the lone assassin, he continued to insist that the first bullet fired did not strike him.

Governor Connally had another difficulty with the Warren Commission's conclusion about the sequence of shots. Although convinced he was struck by the second bullet, he thought the President was hit by the first shot. Yet he admitted that when he turned to his right after hearing the first shot, he did not turn far enough to see the President. The Zapruder film shows the first shot did not affect the President, either. If Governor Connally had continued to turn to see the President, he would have seen Kennedy waving to the crowd.

The primary reason that Connally believed the first bullet hit the President was the testimony of his wife, Nellie.[60] She told the Warren Commission that when she heard the first shot, "I turned over my right shoulder and looked back, and saw the President as he had both hands at his neck. . . . Then very soon there was the

on President Kennedy and all of the wounds on Governor Connally? Failure Analysis Associates applied the latest computer and film-enhancement technology to answer the question of whether one bullet could have caused the wounds and, if so, where the sniper would have to shoot from for the bullet to do the damage. "The most important factor was to have the President and the Governor in the exact locations they were at the time they were shot," said Dr. Robert Piziali, who oversaw the Failure Analysis tests.[64] Failure Analysis used a technique called "reverse projection" to answer the questions. First it created a full-sized model of the presidential limousine. Then a camera was placed in relation to where Zapruder was standing, and the lens was set to the same focal length, so the view of the car was identical to that afforded in the film. Using the Zapruder film, the images of Kennedy and Connally were sketched into the car, and then people who were the exact height and weight of the two men were placed into the seats in the positions shown on the film. Failure Analysis achieved precision on the placement because it used a sonic digitizer, able to make measurements of the bodies from the two-dimensional Zapruder film, and convert them into three-dimensional space. Once the car was filmed, it was placed into animation, and located at the exact spot on Elm Street that it was when the second shot was fired, at frame 224. Then the wounds on the President and Governor were measured and extended into the animation.

At that point the computer was ready to answer two questions. The first was whether one bullet could cause all the wounds, and the answer was yes.[65] The bullet punctured Kennedy's back, exited his throat, and on a straight-line trajectory entered Connally's right shoulder. It struck Connally's rib, and at a downward angle exited under his right nipple. Because he had turned in his seat, the Governor was slightly to the right. His right forearm was held near the lower portion of his chest. The bullet continued through his right wrist and then into his left thigh.

"One of the silliest arguments critics made over the years," says Dr. Michael Baden, "is that the bullet came out of Kennedy's neck, made a right turn to hit Connally's shoulder, then made another right when it left his chest in order to strike his wrist,

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and then completely changed directions and made a left to enter his thigh. Some people still believe that, even though photo enhancements long ago showed the Governor was in such a position that his wounds were clearly the result of one bullet passing straight through him."[66]

The second question resolved by the Failure Analysis re-creation is where the sniper would have to be located for the single bullet to have the correct trajectory. Utilizing the information on the wounds and the location of the men and the car, the computer worked backward to provide a "cone" within which the sniper had to be. "In this case," says Dr. Piziali, "the cone is almost centered on the sixth floor of the Texas School Book Depository. The shot could only have come from within that cone."[67]

The final issue on the single bullet is whether Commission Exhibit 399, the bullet found on the stretcher at Parkland Hospital within ninety minutes of the assassination, could have inflicted the wounds to both men and remained only partially deformed. CE 399, denigrated as the "magic bullet" by buffs, is described as "pristine" in conspiracy books. CE 399 is a fully jacketed military bullet, and ballistics expert Howard Donahue says he was "astonished" when he first personally examined it.* He describes it as "obviously somewhat bent and severely flattened, so much so that a small amount of lead had been extruded from the bullet's base."[68]

"It's called a 'pristine bullet,'" said Dr. Michael Baden, "which is a media term that is inaccurate: it's like being a little bit preg-

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*Mandated by the Geneva Convention of 1922, the purpose of enclosing bullets with full metal jackets was to reduce combat fatalities. The bullets were designed to pass through bodies and, if no major organs were struck, only to wound the victim. Before metal jackets, bullets often detoured inside the body. That the 6.5mm Carcano ammunition was designed to do exactly what it did on the President and the Governor is often ignored. Dr. John Lattimer and Dr. John Nichols created experiments to test the bullet's toughness. Nichols shot a 6.5mm slug through four feet of ponderosa pine boards, and Lattimer put one through two feet of elm wood. Both bullets appeared undamaged (Lattimer, *Kennedy and Lincoln*, p. 272). Moreover, ballistics expert Larry Sturdivan pointed out that another attribute of the Carcano bullet is that it is "one of the most stable bullets we have ever done experimentation with" (HSCA Vol. I, p. 386).

nant—it either is pristine or it is not pristine. This is a damaged bullet and is not pristine. It is deformed; it would be very difficult to take a hammer and flatten it to the degree that this is flattened. This is a partially deformed bullet with a heavy jacket."[69]

Yet CE 399 is not fragmented or crushed. In reconstructions, firing shots into a variety of items, the Warren Commission was unable to duplicate a bullet in the same condition. The Commission test bullet most often cited by critics is CE 856, in which a bullet was fired into a cadaver's wrist to simulate Connally's wrist wound. CE 856 emerged with a badly smashed nose.[70] Since the bullet that did the actual wounds to both men also had to pass through the President's neck, the Governor's chest, and then into his thigh, it seemed to indicate that the stretcher bullet could not be the single bullet.

"Nonsense," says Dr. Lattimer. "What that actually shows is that the Warren Commission did not conduct the proper experiments. They fired a 6.5mm shell traveling at over 2,000 feet per second directly into a wrist bone. Of course you are going to get deformation of the bullet when it strikes a hard object at full speed. If Governor Connally's wrist had been hit on the straight fly by that bullet, CE 399, the bullet would be in much worse shape, and so would his wrist. What the Warren Commission did not understand was that the bullet slowed as it passed through the bodies, and it never hit a hard surface, like bone, on its nose. First it went through Kennedy's neck. When it exited the President, it begun tumbling [rotating] and that is evident by the elongated entry wound on the Governor's back [the bullet entered sideways]. It continued tumbling through his chest, and struck a glancing blow to his rib, knocking out several inches. The gaping exit hole under his right nipple shows the bullet left his chest sideways, entered his wrist while tumbling backwards, and exited with just enough strength to break the skin on his thigh."[71]

Dr. Charles Gregory, the treating physician at Parkland for Connally's wrist and thigh, agreed that based on his examination of the wrist's entry wound, the bullet had been tumbling and entered backward. That the entry wound was large and had an irregular surface, the way in which the muscles were damaged, and that the bullet had picked up organic materials like threads

from Connally's suit and carried them into the wound made Gregory conclude: "The only way that this missile could have produced this wound in my view, was to have entered the wrist backwards."[72] As for the thigh wound, he said the bullet "struck the thigh in a reverse fashion and shed a bit of its lead core into the fascia [a layer of fatty tissue] immediately beneath the skin . . ."[73] Gregory was surprised not to find the bullet, since he realized it had barely penetrated the skin of Connally's thigh. He even "suggested to someone to search the Governor's belongings and other areas where he had been to see if it could be identified or found."[74] Gregory did not immediately think about the stretcher on which the Governor had been brought into the hospital.*

"That bullet slowed in velocity each time it traversed another body part," says Dr. Baden. "There was a debate on our panel [the Select Committee's medical panel] as to whether the bullet even hit Connally's rib or just passed close enough to do the damage. But most of us thought it hit the rib while tumbling, and a sideways hit explains why such a hard bullet is flattened. When it struck the wrist bone, which is small, it was not deformed, since its velocity was so low. By the time it left the wrist, its speed was greatly reduced, and the nature of his thigh wound shows it was a spent bullet by then."[75]**

Dr. Martin Fackler, president of the International Wound Bal-

*Some suggest that CE 399 was planted on Connally's stretcher. CE 399 was found before the surgery on Connally or the autopsy on JFK. At the time it would have to be planted, no one in the supposed conspiracy could know whether the bullets that had been fired at the motorcade were still inside the bodies of the victims. If the conspirators planted a bullet on the stretcher, and then fragments belonging to three different bullets were found in Kennedy and Connally, the plot would have immediately exposed itself by planting a fourth bullet, since there was only time for Oswald to carefully fire three shots.

**Some critics originally charged that the bullet had entered deep into the Governor's thigh and stopped at the femur (thigh) bone. "That's crazy," says Baden. "If it hit the femur, it would never have fallen out. The X ray from the side looks like the fragment left there is on the bone, but that is because you have no sense of depth. However, when you look at an X ray taken on top of the leg, you can see the fragment is barely under the skin and nowhere near the bone."

listics Association, finds the condition of CE 399 "entirely consistent" with a bullet that inflicted the seven wounds on the two men. "It's a long bullet [1.25 inches] and I would expect it to be flattened on the side, just like you had squeezed it in a vise."[76]

Ballistics experts have calculated the speeds at which the bullet would have entered and exited each wound on the President and the Governor. The 6.5mm slug left Oswald's rifle at 2,000 feet per second and hit Kennedy at the base of the neck between 1,700 and 1,800 feet per second. Passing only through flesh, the bullet lost another one to two hundred feet per second and hit Connally at 1,500 to 1,600. It left his chest and entered the wrist at 900 feet per second. Anything above 700 feet per second is enough to shatter bone. When it left the wrist it was near 400 feet per second, just enough to break the skin and imbed itself into his thigh.[77]

Larry Sturdivan, a scientist at the Army's weapons training center at Aberdeen, said such a missile will "not deform because the pressure, due to the lower velocity, is never high enough to deform the bullet."[78]

"That's the key to understanding why CE 399 emerged in whole condition," says Dr. Baden. "I have seen similar bullets that have inflicted gunshot wounds. The bullet was traveling slow enough that, while its speed and density were still greater than the bone it was hitting, it was not moving so fast as to deform seriously the metal jacket. People want an absolute re-creation of CE 399 in tests, but that is impossible. I have seen cases of machine-gun fire at a stationary person, and the bullet paths and injuries produced are never duplicated. There can be minute differences in the manufacture of the ammunition, the condition of the gun that fires it, and the slightest contraction of any muscle on the victim can cause the bullet to take a different path. Re-creation tests on dead bones may not be as helpful, since they can be different than live bones. Bullets react differently to bones with blood going through them as opposed to bones that are dry. The minutest difference in distance between two bullets fired can affect the path of the bullets, the injuries, and the damage to the bullet. Trying to re-create CE 399 is an exercise in futility."[79]

Although a complete re-creation of CE 399 may be impossible, the question of reduced velocity and damage to the bullet can be

tested. For the Warren Commission, the Army conducted separate experiments with 6.5mm bullets, one to determine the effect on a bullet that passed through the President's neck and another to test a bullet going through the Governor's rib. The one that passed through the mock-up of the President's neck (goat skin and meat) was not deformed.[80] The missile that hit the reconstruction for the Governor's rib (an anesthetized goat) did not have the benefit of first being slowed through the President's neck. Yet, still, it only had a slight flattening, similar to CE 399.[81] The remaining question about the condition of the bullet was whether a bullet at a reduced velocity could strike the radius bone in the wrist and emerge in good condition. In 1992 Dr. Piziali, of Failure Analysis, and Dr. Fackler experimented with powder charges. They lowered the velocity on a 6.5mm bullet to 1,100 feet per second and shot it through a cadaver's wrist. "The bullet actually made a slightly greater hole than the one in Governor Connally's wrist," said Dr. Fackler. "That's because the experiment bullet was actually going a little faster than the 900 feet that CE 399 was traveling. The test bullet was non-deformed. It was not flattened in the least and had nowhere near the damage of CE 399."[82]

The final issue in the single-bullet theory involves bullet fragments found in Governor Connally. The FBI randomly weighed 6.5mm Carcano bullets and determined the average weight was 161.2 grains.[83] The stretcher bullet weighed 158.6, meaning only 2.6 grains of its mass were lost.[84] No fragments were left in President Kennedy's neck wound. However, the Governor had three removed from his wrist during surgery, and two small fragments remained in his wrist and one was embedded in his thigh.* According to writers Robert Groden and Harrison Livingstone, in *High Treason*, "There were more than three grains of metal in Connally's wrist wounds alone . . ."[85] That is not true. Dr. Gregory, who performed the surgery on the Governor's wrist, said the fragments he removed "were varying from five-tenths of a milli-

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meter in diameter to approximately 2 millimeters in diameter, and each fragment is no more than a half millimeter in thickness. They would represent, in lay terms, flakes, flakes of metal. I would estimate that they would be weighed in micrograms, which is a very small amount of weight. I don't know how to reduce it to ordinary equivalents for you. It is the kind of weighing that requires a microadjustable scale, which means that it is something less than the weight of a postage stamp."[86] Gregory said the fragments taken from the wrist were so tiny that he did not even plan to take them out, but chanced upon them during surgery.[87] As for the thigh fragment, Dr. Gregory described it as "microscopic, five tenths of a millimeter by 2 millimeters . . . weighing again in micrograms, postage stamp weight . . ."[88]

A reconstruction of weights based upon the fragments removed by Dr. Gregory, as well as the descriptions of those left in Connally, indicates that all the fragments from CE 399 weighed no more than 1.5 grains. That, added to the weight of CE 399 (158.6), is still approximately one grain less than the weight of an average Carcano bullet.[89]

Dr. Gregory, in his Warren Commission testimony, also pointed out that the fragments he recovered from the Governor's wrist were lead, not brass or copper.[90] That is critical because the portion missing from CE 399 is from the soft lead core that protruded from the bottom during its flattening.*

One of the most significant scientific experiments conducted for the single bullet was neutron activation, a nuclear test performed on the fragments. By analyzing the trace elements found in bullet lead, neutron activation makes it possible to determine the probability that different fragments were part of one bullet. In 1974, Dr. Cyril Wecht, the most vocal medical critic of the Warren Commission's conclusions, wrote: "If it had been found that the composition of the lead in the fragment recovered from Gover-

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The House Select Committee engaged Dr. Vincent Guinn, one of the country's most respected experts in neutron activation, to test the stretcher bullet (CE 399), the three fragments removed from Connally's wrist (CE 842), two removed during the autopsy from the President's brain (CE 843), the large mashed fragment found on the front floorboard of the limousine (CE 567), and several small ones found on the rear floor of the limo (CE 840).*

When the House Select Committee announced it had asked Dr. Guinn to undertake that test, the critics were pleased. It is very easy to exclude different items under neutron activation.[92] Most were convinced that the tests would prove that the fragments from Connally's wrist did not come from the stretcher bullet. But they were shocked when Dr. Guinn reported his results. He discovered that the Western Cartridge Co. bullets made for the Carcano were different from any of the other bullets he had tested during twenty years.[93] According to Dr. Guinn, the most striking feature, and most useful for identification purposes, was that "there seems to be no uniformity within a production lot. That is, even when we would take a box of cartridges all from a given production lot, take one cartridge out and then another and then another . . . all out of the same box—boxes of twenty, these were—and analyze them, they all in general look . . . widely different, particularly in their antimony content. . . . In general if you take most boxes of ammunition . . . take a bunch of them out, you can't tell one from the other. They all look like little carbon copies even

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Three pieces of evidence did not contain enough lead to be subjected to neutron activation: FBI No. Q-609, the section of the curbstone near James Tague that was struck by a bullet fragment; CE 569, a fragment recovered from the front floorboard of the presidential limousine; and CE 841, tiny particles scraped from the inside surface of the limousine's windshield.

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Guinn concluded that the all the fragments were Western Cartridge Co. bullets manufactured for the Mannlicher-Carcano rifle. He found they came from only two bullets. "There is no evidence for three bullets, four bullets, or anything more than two . . ." he said.[95] He determined that the fragments from Kennedy's brain matched the three testable fragments found on the floorboard of the limousine, meaning they were all part of the third shot fired.[96] His most important finding was that CE 399, the stretcher bullet, was indistinguishable, both in antimony and silver, from the fragments recovered from the Governor's wrist.[97] Guinn's finding ended the speculation that CE 399 had been planted on the stretcher, since there was now indisputable evidence that it had traveled through Connally's body, leaving behind fragments.*

The critics now tried to say that all that Dr. Guinn's test proved is that the stretcher bullet and the Connally wrist fragments came from the same batch of bullets.[98] But the great difference in the composition of the metal among individual bullets meant that Guinn's conclusion was much more specific than that. He considered the test results as definite as any he had seen in two decades of testing. "The stretcher bullet matches the fragments in the wrist," Guinn said, "and that indicates indeed that that particular bullet did fracture the wrist."[99] When asked if there was a chance that another Carcano bullet could have the same composition as Connally's fragments, he said, "Extremely unlikely, or very improbable, however you prefer."[100]

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grateful for the several days he gave me in Dallas, in addition to the many retired Dallas police sources he led me to. His recollections of the assassination weekend helped me better understand many of those about whom I had to write.

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