

“DREADFUL WERE THE VESTAGES OF WAR”

A live-fire experimental study to validate known bullet-struck objects from the first day of the American Revolution.

by Joel Bohy and Douglas Scott

April 19, 1775, is a date that looms large in American history as the beginning of the American Revolution with the so-called ‘shot heard around the world.’ There are many events and situations that lead to the events of April 19 that are the stuff of history. Our interest in the story of April 19 is not the events leading up to it nor the fight on Lexington Green or at Concord’s North Bridge, but on the performance of the firearms used in those fights as seen in the surviving battle-damaged objects from that momentous day. That being said, a short account of the fight using primary accounts is necessary to understand the battle-damaged objects and structures.

On the night of April 18, 1775, about 750 British regulars began a march from Boston, Massachusetts to Concord, a town about eighteen miles west to destroy warlike stores being stored there. They had been purchased by the Massachusetts Provincial Congress’ Committee of Safety and Supplies to form and supply a Provincial army. Colonel James Barrett of Concord oversaw the materiel along with Captain Jonas Heywood, and the lists of these stores, as well as where they were located, survive.¹ From artillery, cannon shot, tents, musket balls, powder, cartridges, and provisions, to medical kits, wooden bowls, spoons, and fifteen-thousand canteens, it is pretty evident why the British felt they should go to Concord and destroy this material.

The British troops were ferried from Boston Common to Phipps Farm, a piece of land on the Cambridge side of the harbor, owned by loyalist Richard Lechmere. Once assembled they begin their march to Concord. In a letter to an unknown friend Lechmere

wrote “at about 11 oClock at night 700 grenadiers and light Infantry were carried in Boats to my farm, and order’d to march to Concord in order to Destroy some magazines of stores that the Rebels had Lodg’d there, but according to Custom by some means or other they obtained such early intelligence of the design.”² A little earlier that night at about 7 or 8 PM, a British patrol had been spotted on the Concord Road in Cambridge and word got out that the regulars were on the move. Elbridge Gerry, a member of the Committee of Safety and Supplies, had stayed the night at the Black Horse Tavern in the Cambridge village of Menotomy on April 18th after a meeting of the committee. He wrote a note to John Hancock who was staying in Lexington with Reverend Jonas Clarke, that he had seen the British patrol heading west. Reverend Clarke mentioned the information reaching Lexington “On the evening of the eighteenth of April, 1775 we received two messages; the first verbal, the other by express, in writing, from the committee of safety, who were then sitting in the westerly part of Cambridge, directed to the Honorable John Hancock, Esq; (who, with the Honorable Samuel Adams, Esq; was then providentially with us) informing, “that eight or nine officers of the king’s troops were seen, just before night, passing the road towards Lexington, in a musing, contemplative posture; and it was suspected they were out upon some evil design.”³ After receiving the written message, Hancock wrote back to Gerry at 9 PM “I am much oblig’d for your Notice, it is said the officers are gone Concord Road, & I will send word thither I am full with you we ought to be serious, & I hope your decisions will be effectual.”⁴ A few hours later, Paul Revere



Figure 1. Amos Doolittle’s “The Battle of Lexington, April 19th, 1775. Plate I” showing a view of the fighting on Lexington Green, Courtesy of The Miriam and Ira D. Wallach Division of Art, Prints and Photographs, Print Collection, The New York Public Library (<https://digitalcollections.nypl.org/items/510d47d9-7e71-a3d9-e040e00a18064a99>)

and William Dawes, along with many other riders unknown to history would sound the alarm through the countryside. Local militia and minute companies quickly awoke to form and march towards the town of Concord.

At dawn on April 19 the British column marched through Lexington on their way to Concord. The first instance of the British troops losing command and control took place on Lexington Green. Companies of light infantry were placed at the head of the column to hold the two bridges in Concord once they arrived. Captain John Parker, commander of the Lexington militia, had stood with his company on the green. John Robbins, a member of Parker's company wrote what happened next in his deposition of the events just days later "*being drawn up sometime before sunrise, on the green or common, and I being in the front rank, there suddenly appeared a number of the King's troops, about a thousand, as I thought, at the distance of about sixty or seventy yards from us, huzzaing, and on a quick pace towards us, with three officers in their front on horse back, and on full gallop towards us, the foremost of which cried, throw down your arms, ye villains, ye rebels, upon which said company dispersing, the foremost of the three officers ordered their men saying fire, by God, fire, at which moment we received a very heavy and close fire from them, at which instant, being wounded, I fell, and several of our men were shot dead.*"⁷⁵ (Figure 1) Robbins was badly wounded, shot through the back of the neck with the ball shattering his lower jaw and exiting his mouth. Nine others were wounded and eight killed. After the smoke had cleared, the column reformed, cheered, and marched off to Concord.

Concord received the alarm prior to the arrival of the regulars and began the task of removing or hiding as much of the warlike materiel as they could in a short amount of time as well as assembling the minute and militia companies. Thaddeus Blood, a member of Captain Nathan Barrett's militia company remembered "*on the 19th of April 1775, about 2 o'clock in the morning I was called out of bed by John Barritt a Sergt of the Malitia Comy to which I belonged. (I was 20 years of age the 28th of May next following). I joined the company under Capt. Nathan Barrett (afterward Col.) at the old court house about 3 'oclock and was orderd to go into the court house to draw amunition. after the company had all their amun we were paraded near the meeting house.*"⁷⁶ The Concord men were soon joined by others from Lincoln, and it was decided that they should march towards Lexington "*we were then formed, the minute on the right, & Capt. Barrett's on the left, & marched in order to the end of Meriam's hill then so called. & saw the British troops a coming down Brook's hill. The sun was arising & shined on their arms & they made a noble apperance in their red coats & glising arms—we retreated in order; over the top of the hill to the liberty pole erected on the heighth opposite the meeting house & made a halt, the main body of the British marched up in the road. & a detachment followed us over the hill & halted in half gun shot of us, at the pole we then marched over the Burying ground to the road, and then over the Bridge to Flint's Hill, or punckataissett, so called at that time, & were follow by two companies of the British over the Bridge.*"⁷⁷ After their arrival in Concord, the regulars searched the town and destroyed some of the warlike stores, although much of the materiel had been hidden or moved prior to their arrival. Some gun carriages and wheels were burned on the common, musket and cannon balls tossed into the Milldam, as well as flour, salt fish, and other things destroyed. Minute man Amos

Barrett remembered "*Thair was in the town House a number of intrenchen tools witch they carried out and Burnt them. At last they said it was better to Burn them in the house and sot fire to them in the house, but our people Begd of them not to Burn the house, and put it out. It wont long before it was set fire again but finally it warnt Burnt. Their was about 100 Barrels of flower in Mr. Hubbards malt house, the Rold that out an nockd them to pieces and Rold some in the mill pond, witch was saved after they was goon.*"⁷⁸ At around 9 AM, the provincials, numbering around 450, were stationed on a rise above the north bridge. Smoke from the burning stores alarmed the men and it was decided to march to the bridge and into town. One of the British light infantry companies was at the bridge, while two companies were on the west side of the bridge, and with the provincials marching towards them, Blood remembered "*They then retreated over the Bridge & retreating took up 3 plank, and formed part in the road & part on each side, our men the same time marching in very good order, along the road in double file. at that time an officer rode up & a gun was fired. I saw where the Ball threw up the water about the middle of the river, then a second & a third shot, & the cry of fire, fire was made from front to rear. The fire was almost simultaneous with the cry, & I think it was not more than 2 minutes if so much till the British run & the fire ceased.*"⁷⁹ Two provincials were killed as were two British soldiers, with another mortally wounded. British light infantry who had been tasked with holding the north bridge then retreated back to Concord center past the Elisha Jones house. At noon, the British left Concord and were attacked as they reached Meriam's Corner on the outskirts of town. Blood was with the troops that arrived at Meriam's Corner "*every one apeared to be his own commander it was thot best to go to the east part of the Town & take them as they cam back each took his own station, for myself I took my stand south of where Den [deacon] Minot then lived, & saw the British come from Concord their right flank in the meadows, their left on the hill when near the foot of the hill, Col. Thomeson of Billerica came up with 3 or 4 hundred men and there was a heavy fire but the distance so great, that little injury was done on either side, at least I saw but one killed.*"⁸⁰ Fighting raged on and grew in intensity as more provincials arrived. On the west side of Lexington, James Hayward of Acton was shot through his powder horn and mortally wounded at the home of Ebenezer Fiske.

As the British regulars made it back to Lexington center, they met reinforcements, which had been sent out of Boston to meet the retreating column. Reverend William Gordon stated in his history of the event, "*But a little on this side Lexington Meeting-House where they were met by the Brigade, with, cannon, under Lord Percy, the scene changed.*"⁸¹ After the arrival of Lord Percy with his one-thousand men and two six-pound field-pieces, the fighting became more intense and vicious and as mentioned by Reverend Gordon "*the scene changed.*" Homes were looted and put to the torch. (Figure 2) Other houses became a shooting position for Provincial minute and militiamen as well as the place where many would meet their demise. There are many accounts that survive written by both sides relating to what happened that day, and one of the most detailed was penned by an unknown British officer who commanded a company of the 4th Regiment of Foot as a part of Lord Percy's relief brigade. He wrote "*such a scene of Confusion never was & I saw several men killed by our own people firing on them from eagerness you would see a Party of Soldiers firing at the front of a House & another on its rear whilst the main body were pelting away at the upper windows by which means many of*

our own people fell even after they were in the House, & all the World could not prevent it, one Soldier of ours got 11 Balls in him by that means, 4 of which have been cut out, & he is still alive.” He also mentions the loss of command and control “every body did as they pleased some ran this way some that way wherever there was any opposition & for the last 10 miles you could neither find yr. Regiment, Company, Colours nor any thing else, & you could see no more than 6 or 8 men of any Regiment together all mixed & interspersed as if they had been shook out of a Bag whenever an officer run out to clear any place he had a hundred at his heels not of his own Men but of a dozen different Regiments.”¹² This same unknown officer was in the home of 58-year-old Jason Russell in the Cambridge village of Menotomy (now Arlington). The home still stands as a reminder of the events of April 19 and will be discussed in this article. Just up the road was Cooper Tavern, owned by Benjamin and Rachel Cooper. They were in the tavern when the regulars came though Menotomy and wrote a deposition on what transpired that day

“Kings Regular Troops under the Command of Genl. Gage upon their Return from Blood & Slaughter which they had made at Lexington & Concord, fired more than one hundred Bullets into the house where we Dwell through Doors windows & then a Number of them entered the house where we and two aged Gentlemen were all unarmed we escaped for our Lives into the Celler the two aged gentlemen were immediately most Barbarously & inhumanly murdered by them, being stab.d thro in many places their heads mauled sculs broak and their brains out on the floor and walls of the house.”¹³

The intense fighting continued through the western part of Charlestown (now Somerville). As they reached Charlestown neck Jacob Rogers, a former British navy captain and Charlestown resident, wrote

“as I live near the school house in a Back Street: drove into the main street, put my Children in a Cart with others then

driving out of town, who were fired at several times on the Common. and follow.d after: I was abreast of Capt Fentons on the Neck of Land, mr David Waitt Leather dresser of Charles town came riding in full speed from Cambridge. took hold of my Rains, and asserted me to turn up on Bunkers Hill, as he said the troops were then entring the Common. I had just reach.d the summit of the Hill, dismounted from the Chaise and tied it fast in my father in Laws Pasture when we saw the Troops within about forty Rod of us on the Hill. One Hayley a Taylor: now at Cambridge, with his Wife and a gun on his Shoulder, going towards them, drew a whole volley of shot on him self and us, that I Expected my Wife or one of her sisters who were with us to drop every moment. it being now a little dark we proceeded with many others toward the pert house till we arrived at Mr Townsends Pump maker in the Training field, on hearing Womens voices we went in. and found him, Capt adams, Tavern keeper, Mr Samuel Cary, now Clark to Collonel Mifflin Quarter master general, and some Others, and a House full of women and Children in the greatest Terror; afraid to go to their own Habitations. after Refreshing our solves it being then dark Mr Cary myself and one or two more went into Town to see if we might with safety proceed to our own houses. on our way met a Mr Hutchinson who inform.d us all was then pretty quiet, that when the soldiers came through the street the Officers desired the Women & Children to keep in doors for their safety, that they Beg.d for drink. which the people were glad to Bring them for fear of being ill treated Mr Cary and I proceed to the Tavern by the Town House where the officers were. all was Tumult and confusion Nothing but drink call.d for every Where, I stay.d a few minutes and proceeded to my own house and finding things pretty quiet went in search of my Wife and sisters and found them coming up the Street with Capt adams, on our arrival at home we found her Brother a youth of fourteen was shot dead on the Neck of Land by the soldiers as he was looking out of a Window.”¹⁴



Figure 2. Amos Doolittle’s “A View of the South Part of Lexington Plate IV” showing the arrival of Lord Percy’s reinforcements and the burning of homes, Courtesy of The Miriam and Ira D. Wallach Division of Art, Prints and Photographs, Print Collection, The New York Public Library (<https://digitalcollections.nypl.org/items/510d47d9-7e71-a3d9-e040e00a18064a99>).

The fighting ceased and the regulars were ferried back to Boston that night.

But the alarm had spread, and thousands of men, perhaps as many as 3600, were forming and marching towards Boston. One of the men who arrived too late for the fight but witnessed the death and damage was Amos Farnsworth, a Provincial militiaman from Groton. He arrived in Lexington and Menotomy (Arlington) later in the afternoon or evening. He wrote in his diary "*Wednesday morning, April 19, 1775. was Alarmd with the news of the Regulars Firin At Our men At Concoord Marched and Came thare ware Some had Been ciled Puled on and Came to Lexington whare much hurt was Done to the houses thare by braking glas And Burning Many Houses: but thay was forsed to retret tho they was more numerous than we And I saw many Ded Regulars by the way.*"¹⁵

On the morning of April 20, Reverend David McClure rode out to the scene of the battle. He wrote in his diary

*"Determining to see what had been done on the rout of the enemy, I rode to Watertown & from thence came on the road to Lexington. I went almost to the meeting house, were the first American blood was wantonly spilt, but the rain necessitated me to return. Dreadful were the vestages of war on the road. I saw several dead bodies, principally British, on & near the road. They were all naked, having been stripped, principally, by their own soldiers. They lay on their faces. Several were killed who stopped to plunder & were suddenly surprised by our people pressing upon their rear. The houses on the road of the march of the British, were all perforated with balls, & the windows broken. Horses, cattle & swine lay dead around. Such were the dreadful trophies of war, for about 20 miles!"*¹⁶

These, and other first-hand accounts help historians understand and maybe even to visualize how ferocious the fighting actually was on April 19.

Premise of the Live-Fire Study

The study we present here was done in support of a book entitled *Bullet Strikes from the First Day of the American Revolution*.¹⁷ In our book, we have covered the arms and ammunition used by both provincial and British forces, and all known bullet-struck architectural structures and objects. Using modern forensic shooting incident reconstruction methods, we have recorded all of the strikes, estimated each ball strike caliber, who fired the shots (provincial or British), and reconstructed the shooters' approximate position. Here we present details of a live-fire experiment that was designed as a validation study to determine if 18th century British Brown Bess muskets could have caused the damage observed in the original surviving bullet-struck objects we recorded.

Our study was generously supported by a grant from the American Society of Arms Collectors Foundation. We are very grateful to the Foundation for the grant as it allowed us to cover the cost of renting a high-speed video camera and other costs related to conducting our experiments.

Our study used the surviving bullet-struck items, most of them in the Jason Russell house, not just as pieces of material culture that still bear the physical scars of the fighting that took place in and around the structures in the afternoon and early evening of April 19, but as revered objects of memory of a momentous event in American history. In one view we see the architectural element and the bullet holes as part of a micro history study of a specific

place. In a larger context we see the Jason Russell house and other preserved bullet-struck architectural artifacts as part of landscape of conflict that is seared into the history of the founding of the United States. Applying modern forensic shooting incident reconstruction methods adapted to an archaeological construct to study these poignant reminders of the first day of the American Revolution has given us a new perspective on the past.

The live-fire experiment was conducted to determine if we could replicate spherical ball-damaged objects surviving from April 19, 1775, the first day of the American Revolution. The standing structures damaged by gun fire on April 19 now exist amidst a modern built and modified landscape. However, those buildings and places still remain and anchor us to that past by their very existence. These places, Elisha Jones' shed, Munroe Tavern, Buckman Tavern, Marrett Munroe house, Jason Russell house, and other preserved artifacts have become "hallowed" because they either still stand, or related pieces exist in collections.¹⁸ As historic objects they were a part of a signal event and embody those events which they witnessed. A bullet hole in a wall is mute testimony to that past conflict but is not mute to us. Physical evidence has much to say about the past when studied in the greater context of the British retreat that was contested by organized provincial minute and militia companies from Concord to Charlestown.

Components of the Study

The live-fire experiment used a custom-built reproduction British Pattern 1756 Long Land flintlock musket. Other components of the experiment included the firing range, consideration of the black gunpowder used as a propellant, standardization of the lead balls, the construction of authentic style cartridges, the construction of targets, and the methods of data collection.

We shot sections of house walls that we had built using salvaged original colonial-era building materials, an indoor window shutter, interior panels that replicated bullet-damaged walls, and a powder horn. We employed human tissue simulant ballistic gelatin block and a head and bust for two of the validation studies in order to ascertain the effect of lead balls on the human body. All shots were recorded with high-speed videography focusing on the bullet strike and associated damage as well as determining the velocity of the ball when it struck the target.

Exterior ballistics is the study of the performance of a bullet after it leaves the gun. As Lucien Haag observes, there is a difference in what a ballisticsian and a forensic scientist, or for our purposes an archaeologist, is seeking in studying bullet performance.¹⁹ The forensic scientist or conflict archaeologist is seeking to reconstruct a shooting incident or event based on residual physical evidence, the artifact, and knowledge of one or more types of firearm ammunition's ballistic properties and performance.

External ballistics for post-1900 firearms and bullets are relatively well known and is the continuing subject of analysis as new smokeless gun powders and conical bullets are developed. Datasets on external ballistics and bullet performance are limited for the soft lead spherical balls and cylindro-concoidal bullets of the preceding centuries, especially the spherical lead ball. A great deal of lore and apocryphal information exists on the ranges and performance of these historical bullets. There are good summaries of test shooting, largely at pine boards and thick catalogs or telephone books to determine bullet penetration at various ranges that were conducted in the nineteenth century and well into the

twentieth century.²⁰ These data are of limited value to the modern researcher. Thus, it became necessary to conduct firsthand live-fire research with a variety of weapons under controlled experimental conditions to ascertain the behavior of spherical bullets and other projectiles that will enhance our understanding of lead bullet behavior of the pre-1900 era.

High-Speed Video Camera

The high-speed camera setup consisted of a Fastec Imaging TS3 Cine camera mounted on a tripod and connected by cables to a laptop computer. The camera was remotely controlled and collected data on the shot. The camera was set to record 2500 frames per second. The data was downloaded to the computer and field processed in Cine Viewer and saved on an external hard drive. Boxer LED spotlights with appropriate filters/gels were employed as necessary to better light the targets (Figure 3).



Figure 3. The Fastec high-speed camera being calibrated for a shot at a wall panel.

Firearm Used in the Experiment

A British Pattern 1756 Long Land musket, aka “Brown Bess,” in .76-caliber, represented the standard British infantry firearm used in the American Revolution. The Pattern 1756 and the Pattern 1769 Short Land musket were what was being carried by British enlisted men during the war. The major difference between the two arms was that the Pattern 1769 barrel was four inches shorter than the Pattern 1756.²¹(Figure 4).

Information on the diameter and weight of Revolutionary War musket and fowling piece balls comes largely from the archaeological record. As a part of our study, we recorded the data from all known balls found that relate to April 19, as well as a study sample of British musket balls found on other Revolutionary War sites.

The spherical balls used in the live-fire experiment were commercially cast soft lead bullets. A sample of the balls were weighed,

and the diameter measured during the preparation work. The experimental spherical ball weights show a minimum of 1.5 grain (0.1-gram) to a maximum of 4.6 grain (0.3-gram) weight variation. The measured nominal .69-inch ball diameters also showed very little variation, being about 0.001 to 0.003-inch among all the balls measured. They have far less variation in weight and diameter than any of the published historical ball diameters or archaeological specimens reported. The balls are less than bore size. Typically, balls were less than bore-sized to allow ease of loading, especially after multiple rounds were fired which caused black powder fouling in the bore. The common term for this is windage.

Live-Fire Validation Study

The British 1756 Long Land Pattern musket, .76-caliber, was fired 20 times using a 110-grain charge with a .69-inch ball in a paper cartridge. Three of those shots were test firings used to calibrate the camera. No velocity data was recorded for the test shots. The muzzle velocity ranged from 729 to 971 f/s for the remaining 17 shots (Table 1). Two of the three test shot balls were recovered as were nine of the targeted shot (Figure 5).

Table 1. Recorded Velocity of Shots Fired During the Validation Study

Building or Object	Shot Number	Velocity ft. per sec.	Velocity meters. per sec.
Elisha Jones	1	888	237.1
Elisha Jones	2	815	248.4
Powder horn 1	1	833	253.9
Powder horn 2, graze	1	795	242.3
Powder horn 2, hit	2	856	260.9
Wall section 1 & panel	1	778	221.2
Wall section 1 & panel	2	760	231.6
House interior panel	1	853	259.9
House interior panel	2	971	295.9
Plastered wall section	1	888	270.6
Plastered wall section	2	906	276.1
Shutter	1	729	222.1
Shutter	2	880	268.2
Shutter	3	807	245.9
Shutter	4	905	275.8
Shutter	5	648	197.5

The live-fire experiment used Clear Ballistic® gelatin obtained from Clear Ballistics®. Clear Ballistic gelatin meets the FBI and NATO protocols for testing terminal ballistics of human tissue simulants. The protocol standard states that an acceptable calibrated gelatin must have a steel BB (.177-inch or 4.5mm in diameter) shot at 590 f/s (180 m/s) at 10 feet (3.04m) come to rest between 1.73 and 1.8 inches (4.4 and 4.6cm) into the gelatin. A Clear Ballistics block, 6x6 inches square and 16 inches long, was used for the powder horn shots. The block was placed on a wooden cable

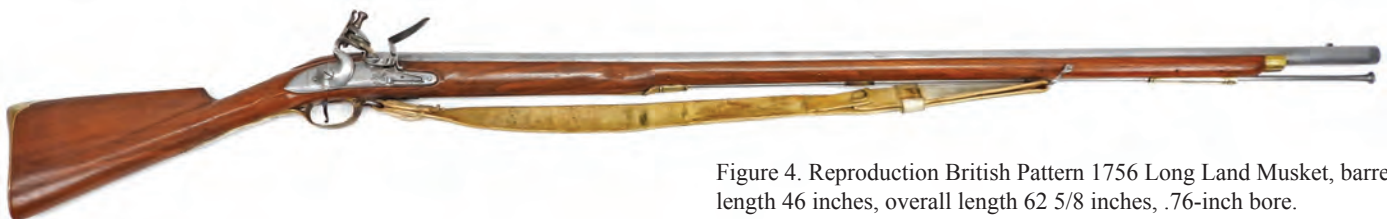


Figure 4. Reproduction British Pattern 1756 Long Land Musket, barrel length 46 inches, overall length 62 5/8 inches, .76-inch bore.

spool covered with 2 ½ inch thick foam pads. A roughly 6x6 inch square with layers of cloth, meant to simulate the thickness and weight of average colonial era clothing, was placed on the front of the block.



Figure 5. Jay Waller preparing to fire the Pattern 1756 Long Land musket that was used during the live-fire shooting.

The cloth squares were made up of wool broadcloth followed by a piece of serge to represent a coat and lining. Behind these was another piece of broadcloth and a piece of serge to represent a waistcoat and lining. The final piece of cloth was a square of linen representing a shirt. The cloth was replica fabric that is the same weight and weave of known historic cloth constructed of similar materials.²²

A Clear Ballistics bust in the form of synthetic bone skull filled with synthetic blood, lower jaw, spinal column, and clavicles embedded in ballistic gelatin that was cast as a face, neck, and upper shoulders was used for one shot. The shot was an attempt to replicate the wound suffered by John Robbins at Lexington Green on the morning of April 19.

Bullet-Struck Architectural Elements Validation Results

Test Shots

Three test shots were fired with the reproduction British Pattern 1756 Long Land musket to calibrate the camera to later be able to calculate ball velocities.

Test shot 1- Ball not recovered.

Test shot 2 - Ball recovered in berm. High-velocity impact damage due to hitting a rock. The ball weighed 30.77 grams/474.8 grains. It had a loss of 1.13 grams/23.66 grains.

Test shot 3 - Ball recovered in berm. The ramrod mark is present, and it has a low-velocity impact with almost no damage. The ball weighed 31.92 grams/492.6 grains with a loss of .38 grams/6 grains.

Wall Section 1, Clapboard Siding, Sheathing, and Interior Panel

Wall section 1 was set up to simulate a bullet hole recorded in the Jason Russell house (Figure 5) upstairs parlor over the kitchen. There we found a bullet hole in the exterior wall sheathing (the exterior clapboard was replaced during restoration work) that was aligned with a bullet hole in the interior wall panel across the

room. There was a bullet strike on the underside of the attic flooring that also aligned with the shot. That strike did not penetrate the wood flooring, but a lead smear is present suggesting the bullet had reached its terminal velocity after passing through the clapboard siding, wall sheathing and interior paneling, and the interior wall panel across the room. (Figure 6)

We set wall section 1 30 feet (9.8 meters) from the shooter with the interior wall 15 feet (3 meters) from the wall section to simulate the kitchen upstairs parlor wall shot based on the hypotenuse of the shot angle. Two shots were fired and hit the targets passing through all four layers of wood.

Shot 1 passed through clapboard, sheathing, interior wall panel and interior wall panel across the room. It was recovered in the earthen backstop at a depth of 10 inches (25.4cm). The ball struck rock and there is high-velocity impact damage to the bullet. The muzzle velocity was 726 f/s (721.28 m/s) at the time it struck the clapboard siding. The ball weighed 30.66 grams/473.1 grains. Weight loss is 1.64 grams/25.36 grains. The ball hole in the clapboard is circular and is .70-inch in diameter. The holes in the clapboard and interior wall panel tested positive for lead residue when subjected to the presumptive lead test.

Shot 2 passed through clapboard, sheathing, interior panel and interior wall panel across the room. It was recovered in the backstop at a depth of 8 inches (20.32cm). The ball struck rock and there is high-velocity impact damage to the bullet. The muzzle velocity was 760 f/s (231.6 m/s) at the time it struck the clapboard siding. The ball weighed 31.97 grams/491.8 grains. Weight loss is .33 grams/6.66 grains. The ball hole in the clapboard is circular and is .70-inch in diameter.



Figure 6. The bullet-riddled Jason Russell house, home of the Arlington Historical Society.

Wall Section 2, Clapboard Siding and Sheathing

Wall section 2 consisted of clapboard siding and sheathing meant to simulate the wall of the Elisha Jones shed that was struck by a ball on April 19 and in the Jason Russell house attic. The live-fire experiment was conducted to validate our assumptions that the bullet holes in the Elisha Jones shed and in the attic of the Jason Russell House are consistent with spherical bullet strikes and their associated damage. We used a replica wall section consisting of clapboard and sheathing nailed to studs on either side.

We fired two shots from a reproduction British Pattern 1756 Long Land .76-caliber musket using a 110-grain black powder

charge with a .69-inch (17.52 mm) diameter lead ball from a distance of 30 feet (approximately 9.14 meters) from the wall section. The shots were fired from a clean bore. Both shots struck and penetrated the wall section leaving clean nearly circular holes, passing through the sheathing, and then embedding themselves in the berm backstop. Neither ball was recovered from the backstop. (Figure 7).



Figure 7. Ball strikes in Wall section 2.

Both balls passed through the exterior clapboard and sheathing (Figures 21, 22). The first ball had a recorded velocity of 778 f/s (237.13 M/s) as it struck the clapboard and ball 2 had a recorded velocity of 815 f/s (248.4 m/s) as it struck. The first bullet hole had a minor axis of .634-inch (16.1 mm) and a major axis of .683-inch (17.3 mm). The second bullet hole had a minor axis of .62-inch (15.9 mm) and a major axis of .694-inch (17.6 mm). Shot 1 struck the panel near a joint between two pieces of sheathing which splintered and left a large blowout where the ball exited, mimicking the hole in the Elisha Jones shed. Both balls embedded themselves in the backstop berm. (Figure 8)

Based upon our live-fire ballistics studies, the study of the Jason Russell house in Arlington and the Elisha Jones shed, we believe the physical traits observed on the hole in the Elisha Jones shed are consistent with other documented April 19 bullet holes.

Wall Section 3, Wall and Plaster Panel

Wall section 3 was a section of interior wall panel with lath and plaster on the opposite side. This wall section simulates the interior lower parlor wall of the Jason Russell house and assumes the bullets either passed through an open window or through glass panes. Two shots were fired at the interior panel and plaster wall section. Both balls were recovered. The first ball struck the panel at 888 f/s (270.6 m/s) and the second at 906 f/s (276.1 m/s). Both passed through the interior wall panel and the lath and plaster.



Figure 8. Wood splintering around the bullet holes in Wall section 2. Note the extreme splintering around the lower hole near the feather edge joint which nearly duplicates that found on the interior of the Elisha Jones shed sheathing.

Wall and Plaster shot 1 was recovered buried about 10 inches in the backstop. The bullet exhibits low to moderate impact damage from striking the rock-strewn earthen backstop. The bullet weighed 31.58 grams/487.6 grains for a loss of .72 grams/10.86 grains. The bullet hole has a minor axis of .617-inch (15.6 mm) and major axis of .693-inch (17.6 mm).

Wall and Plaster shot 2 was recovered about 4 inches in the backstop. It struck rock and had high-velocity impact damage. The bullet weighed 31.06 grams/479.4 grains for a weight loss of 1.24 grams/19.06 grains. The bullet hole has a minor axis of .645-inch (16.4 mm) and a major axis of .744-inch (18.9 mm).

Exit damage on the plaster from both shots were semi-circular in shape. The plaster was blown away, largely as dust, with oval to round holes left in the lath and the plaster.

Panel Shots

A wall panel was used to simulate bullet strikes in a door panel or an interior wall panel where the bullet may have struck a door as at the Buckman Tavern or gone through an open window or a glass windowpane striking an interior wall panel, as recorded in the lower parlor of the Jason Russell house. Two shots were fired but neither ball was recovered.

Panel shot 1 – The bullet struck the panel at 853 f/s (259.9 m/s). The hole in the interior wall panel is .653-inch (16.5 mm) in the minor axis and .689-inch (17.5 mm) in the major axis.

Panel shot 2 – The bullet struck the panel at 971 f/s (295.9 m/s). The hole in the interior wall panel is .538-inch (13.6 mm) in the minor axis and .672-inch (17 mm) in the major axis.

Damage from both shots to the interior wall panel/door panel on their backsides consisted of a large area of wood loss and significant splintering exhibited at the exit sites. These shots mimic those observed in the Buckman Tavern door panel and the interior wall panel at the Jason Russell house.

Shutter Shots

A salvaged indoor shutter panel was shot five times to simulate bullet holes in preserved April 19 bullet-damaged shutter panels saved from colonial-era homes that have been demolished. The original panels are part of the Arlington Historical Society collection. Bullets from Shots 1 and 3 were recovered. The five shots have recorded velocities of Shot 1 729 f/s (221 m/s), Shot 2 880 f/s (268.2 m/s), Shot 3 807 f/s (245.9 m/s), Shot 4 905 f/s (275.8 m/s), and Shot 5 648 f/s (197.5 m/s). The bullet from shot 1 weighed 30.97 grams/477.9 grains with a weight loss of 1.33 grams/20.56 grains. The bullet hole has a minor axis of .688-inch (17.47 mm) and a major axis of .732-inch (18.6 mm). Shot 2 was not recovered but the bullet hole has a major axis of .699-inch (17.7 mm). The minor axis could not be measured as the bullet struck the shutter edge leaving an open hole. Shot 3 was recovered and weighs 31.88 grams/ 492.1 grains. Weight loss is .42 grams/6.36 grains. Shot 4 was not recovered but the bullet hole has a minor axis of .660-inch (16.7 mm) and a major axis of .738-inch (18.7 mm). Shot 5 was not recovered but the bullet hole has a minor axis of .682-inch (17.3 mm) and a major axis of .721 inch (18.3 mm). Both recovered bullets struck rock in the backstop, causing high-velocity impact damage. (Figure 9). The back of the shutter shows extensive wood loss and splintering around each of the bullet impact holes. Both the entrance holes and the exit holes as well as the bullet strike locations on the shutter mimic the holes observed and recorded on the original bullet-struck shutters in the Arlington Historical Society collection.

James Hayward Bullet-Struck Powder Horn Live-Fire Validation Study

James Hayward (1750-1775) is mentioned in many historical

publications as a 25-year-old schoolmaster from Acton. Although he may have been, a search of the Acton town records from 1770-75 do not mention him nor show him being paid as a teacher.²³ Hayward was possibly a member of Lieutenant Simon Hunt's Acton militia company who marched on the April 19 alarm; he was at the North Bridge in Concord and fought during the British retreat. In the early afternoon of April 19, he purportedly stopped at the Ebenezer Fiske house, approximately a mile west of Lexington center, for a drink of water from the well. An encounter with a British soldier followed with the soldier being killed and Hayward being mortally wounded. Rebekah Fiske, daughter-in-law of Ebenezer Fiske, who lived at the Fiske house in 1775 where the incident took place, had her story of the events recorded in 1827. She had vacated her house with her elderly father-in-law to a neighbor's house to wait out the battle, and

“After the rattle of musketry had grown somewhat weaker from distance, and my heart became more relieved of its apprehensions, I resolved to return home. But what an altered scene began to present itself, as I approached the house - garden walls thrown down - my flowers trampled upon - earth and herbage covered with the marks of hurried footsteps. The house had been broken open, and on the doorstep - awful spectacle — there lay a British soldier dead, on his face, though yet warm, in his blood, which was still trickling from a bullet-hole though his vitals. His bosom and his pockets were stuffed with my effects, which he had been pillaging, having broken into the house through a window. On entering my front room, I was horror-struck. Three mangled soldiers lay groaning on the floor and weltering in their blood, which had gathered in large puddles about them. “Beat out my brains, I beg of you,” cried one of them, a young Briton, who was dreadfully pierced with bullets, through almost every part of his body, “and relieve me from this agony.” You will die soon enough, said I, with a revengeful pique. A grim Irishman, shot through the jaws, lay beside him, who mingled his groans of desperation with curses on the villain who had so horridly wounded him. The third was a young American, employing his dying

Figure 9. Five bullet strikes in a salvaged indoor window shutter that replicates bullet strikes observed in surviving shutters in the Arlington Historical Society collection. Right: Exit holes showing the wood splintering after the ball passed through the shutter.



breath in prayer. A bullet had passed through his body, taking off in its course the lower part of his powder-horn. The name of this youthful patriot was J. Haywood [sic Hayward], of Acton. His father came and carried his body home; it now lies in Acton graveyard. These were the circumstances of his death: being ardent and close in the pursuit, he stopped a moment at our well to slake his thirst. Turning from the well, his eye unexpectedly caught that of the Briton, whom I saw lying dead on the door-step, just coming from the house with his plunder. They were about a rod from each other. The Briton knew it was death for him to turn, and the American scorned to shrink. A moment of awful suspense ensued—when both simultaneously levelled their muskets at each other's heart, fired, and fell on their faces together. My husband drew the two Britons off on a sled, and buried them in one of our pastures, where they now lie, beneath a pine tree which has grown up out of their grave. The Irishman was the only one of the three that survived."²⁴

She was there soon after the incident occurred and is the closest witness we have to the event.

Hayward's bullet-struck horn (Figure 10) became an important reminder of the fighting on April 19, and in 1835, the statesman Edward Everett was in Lexington giving an oration for the anniversary. One of the important objects brought out was Hayward's horn,

*"Among the interesting mementos of the 19th of April, 1775, to which the attention of the company assembled at Lexington on Monday last, was the Powder Horn, worn by Mr. James Hayward of Acton, who was killed in Lexington, during the pursuit, and which was perforated by the ball, that entered Mr. Hayward's body. Mr. [Edward] Everett observed that he had been requested by the owner of this interesting relic, Mr. Stevens Hayward of Acton, (the nephew of the person, by whom it was worn on the 19th of April, 75) to exhibit it to the company, and to mention its history."*²⁵

In 1870 an article appeared in the newspaper about the Hayward horn, which is a little confusing, but it answers some questions *"Acton, by the bequest of Edward Everett, is now in the possession of the powder-horn worn by James Hayward, who was killed at Lexington while pursuing the British from Concord. Mr. Everett, while it was in his possession, had it bound with silver, and a silver neck chain attached."* An 1851 engraving of the horn in *Gleason's Pictorial Drawing-Room Companion* shows the horn with the silver-bound edge on the plug, a silver escutcheon, and chain, so it was at least done prior to the dedication of the monument in that year. The article may be confusing Edward Everett with Ste-

vens Hayward, the grandnephew of James Hayward, who owned the horn until he died in 1868. Everett died in 1865, a few years prior to Stevens Hayward. Also in 1870, the original gravestones of Captain Isaac Davis, Private Abner Hosmer, as well as James Hayward were moved from Woodlawn cemetery and placed on the grass slope around the 1851 monument *"The tombstones erected to the memory of those named in the above transcription [Davis, Hosmer, and Hayward] have just been taken from the old burying ground, and will to-day be placed in the embankment at the foot of the memorial."*²⁷

Reverend Artemus Bowers Muzzey, a minister who had been born in Lexington, and was at the 1835 Patriot's Day ceremony where he heard Edward Everett's oration saw the Hayward horn,

*"I often heard from my grandfather the history of the encounter between James Hayward of Acton and a British soldier at a house by the foot of Fiske hill...I recalled the memorable well with new interest April 19, 1835. It was then, when the remains of the martyr soldiers were placed under the monument at Lexington, that Edward Everett, the orator of the day, exhibited the powder-horn worn by Hayward in that deadly encounter. I saw the hole made by the bullet which killed him, and was glad to learn recently that this venerated relic was bequeathed by Mr. Everett [Stevens Hayward] to the town of Acton, and is now deposited in that place."*²⁸

Hayward's horn continued to be displayed and even removed from the town to share with others. In April 1887, Luther Conant, a state politician from Acton, brought it to Boston, *"Mr. Luther Conant of the Third Middlesex District has exhibited recently to his associates in the House a Revolutionary relic of rare historic merit. It is the powder horn worn by James Hayward of Acton, who was killed at Lexington on the 19th of April, 1775....The horn is the property of the town of Acton and his highly prized."*²⁹

The horn has been on display at the back of the Acton Memorial Library for many years. In 2013, it was borrowed by the Concord Museum for an exhibition titled "April 19, 1775: The Shot Heard Round' the World." After that exhibit, it went back to the Acton Memorial Library until it was borrowed by the Museum of the American Revolution in Philadelphia and was on exhibit there until returned to Acton in the fall of 2023.

The Hayward horn is left-handed, and it would have been worn partially on his left/back side, although it could have swung down in front of his body when the shooting incident occurred. A ball passing through the horn may well have caused horrific wounds to his left back side or abdomen. The entrance hole is .70-inch diam-



Figure 10. James Hayward's bullet-struck horn. Acton Memorial Library.

eter on the surviving horn and is consistent with the diameter of a British musket ball. There is a small piece of horn missing from the entrance hole located near the end plug, and there are a few small cracks radiating from the central bullet hole. The exit hole of the horn is blown out, taking the thicker shards of horn away and leaving a large, jagged hole. The original pine plug was probably blown out of the back of the horn when it was hit by the British ball and a later plug was installed by Stevens Hayward. It has a silver band around the edge of the horn and plug which is engraved on the plug side "*Presented to the town of Acton by Hon Stevens Hayward.*" The slightly convex plug has an oval silver escutcheon marked "*James Hayward/of Acton/was killed in Lexington/on the 19th of April, 1775./by a ball which passed through his Powder Horn/into his body.*"³⁰ The horn is in the collection of the Acton Memorial Library.

Examination and documentation of the powder horn provided us information on which to base a shooting incident reconstruction. According to historical accounts, the event revolved around a well. The Rebekah Fiske account mentioned above states that the shooting incident was probably about 1 rod (16.5 feet, or 5 meters) from the house. We chose to use that distance for our live-fire shooting incident reconstruction. The reconstruction used two plain antique powder horns. Each horn was placed in front of a human tissue simulant, ballistic gelatin block, and each horn was shot individually.

Powder Horn Shot 1

The horn is an antique colonial-era powder horn. The horn was placed in front of a human tissue simulant ballistic gelatin block that is 6 inches square and 16 inches long. Between the horn and gel block a square of layered cloth was placed to replicate a wool coat with a serge lining, a waistcoat and serge lining, and a linen shirt. Shot 1 ball was traveling at 833 f/s or 253.9 m/s when it struck the horn. The entrance hole is obvious. The ball caused the horn to shatter, breaking into large and small fragments. The wooden end plug which is fastened to the horn by hand-wrought cut brads was not dislodged. The horn body shows significant radiating fracture lines as well as loss of the horn body from the ball strike.

The high-speed video of the ball passing through the horn (Figure 11) shows that it split into two pieces on the horn shards as it passed through the cloth and into the gelatin block. Bullet velocity was recorded as 833 f/s (253.9 m/s). The wound track or path the two pieces took is clear in the video and the ball fragments lost

kinetic energy with the large piece (weighing 19.39 grams/299 grains) stopping 9 inches (22.8 cm) into the gelatin block. The smaller piece (weighing 12.7 grams/187.8 grains) stopped 7.5 inches (19 cm) into the gelatin. Both wound tracks contained fragments of cloth and horn shards weighing in total 3.1 grams. One ball fragment has cloth embedded in the ball edge as well as a horn shard piece.

The two ball fragments weighed a total of 31.55 grams/486.9 grains. This is a total weight loss of only .075 grams/11.56 grains. This is not a substantial weight loss despite the extensive destruction of the horn and being split by the horn shards as it entered the gelatin block.

The horn was reconstructed from the fragments collected from around the target site. The shards from the wound track were not used in the reconstruction. The horn's bullet exit area (approximately 3 inches/7.5 cm by 1.5 inches/3.5 cm) could not be reconstructed due to extreme fragmentation of the horn into small shards, some of which were carried into the wound tracks.

Powder Horn Shot 2

A second colonial-era powder horn was also shot. It too was placed in front of the gelatin block with the cloth piece between the horn and the block. The ball of the first shot just grazed the horn creating a 1.25 x .75-inch (3 x 2 cm) hole on the horn's surface. The ball was traveling at 795 f/s or 242.3 m/s. The ball passed through the entire gelatin block (16 inches/40.6 cm) and was recovered in the berm. It weighs 31.67 grams/488.79 grains. The total weight loss is .63 grams/9.67 grains. The ball was examined under magnification and the surface exhibits cloth impressions where it passed through the cloth. Very small pieces of horn are also embedded in the ball surface.

The second shot passed through the horn leaving an entrance hole .5 x .75-inch (1.5 x 2 cm) in shape with an elliptical exit hole that is .75 x 1 inch (2 x 3 cm). The shot caused the horn to shatter into six large pieces and many smaller fragments. The end plug, which is fastened to the horn with wood plugs, was blown out. The ball was traveling at 856 f/s or 260.9 m/s when it hit the horn. The ball was recovered in the berm with fabric weave impressions and tiny bits of horn embedded in the ball surface. The ball weighs 31.22 grams/483.4 grains with a total weight loss of 1.08 grams/15.06 grains.

The horn was reconstructed with only a few small missing pieces. The graze hole for ball 1 and the entrance and exit hole for ball 2 are clearly visible. Like the first horn the second horn body



Figure 11. High-speed video of the ball passing through the horn. Right: The split ball, cloth fragments and horn shards removed from the wound track in the ballistic gelatin. The cloth and horn fragments weighed 3.1 grams.

shows significant radiating fracture lines as well as loss of the horn body from the ball strike.

The original Hayward horn shows body loss and radiating fractures as a result of being struck by a ball. The old dry horns we used in the replication and validation experiment shattered and fractured when struck by the balls, but they reasonably approximate the bullet damage seen on Hayward's horn. The wound effect seen in the shooting incident reconstruction study with the ball carrying cloth and horn shards into the wound is likely very similar to the wound James Hayward suffered when his horn was hit by the British ball. No doubt the horn shards entering his wound along with the ball were contributing factors to his death on April 19.

John Robbins Wound Live-Fire Study

One of the members of Captain John Parker's Lexington militia company wounded on Lexington Green on the morning of April 19, 1775, was John Robbins. His name not only appears in the newspapers of the period and history books, but he was one of the men who wrote a deposition on April 24, 1775, for the Provincial Congress attesting to what happened that morning:

"I John Robins being of lawfull age, do Testify & say that on the nineteenth Inst. the Company under the Command of Capn. John Parker; being drawn up, (sometime before sun Rise) on the Green or Common, And, I being in the front Rank, there suddenly appear'd a Number of the Kings Troops, About a Thousand as I thought, at the distance of about 60, or 70 yards from us Hazzar[d]ing and on a quick pace toward us, with three officers in their front, on Horse Back and on full Gallop towards us, the foremost of which cryed, throw down your Arms ye Villains, ye Rebels, upon which said Company Disperseding. - The foremost of the three Officers orderd their Men, saying fire, by God fire, at which Moment we Received a very heavy & close fire from them, at which Instant, being wounded I fell, Several of our men were shot Dead by one, Capn. Parkers men, I believe had not then fired a Gun and further the Deponant saith not –

John Robins"³¹

After April 19 and the Battle of Bunker Hill a few of the wounded men began to ask the state for help. Their wounds, in some cases, made them unable to work and make a living. Medical bills were also growing and with no income how could they pay the bills and provide for their families? Many of these petitions for a pension, or after December 1775 for lost and broken material, are in the collection of the Massachusetts State Archives spread through numerous volumes. The earliest petition found for Robbins is from June 14, 1776, and it gives a description of his wounds (Figure 12):

"To the Honorable the Colony Council & the Honorable the House of Representatives in general Court assembled

The Petition of John Robbins of Lexington Humbly Sheweth, That your Petitioner was on the memorable 19th of april 1775 most grievously wounded. by the Brittish Troops in Lexington, by a musket ball which passd by the left of the spine between his Shoulders through the

length of his neck making its way through and most miserably Shattering his under jaw bone, by which unhappy Wound your Petitioner is so much hurted in the Muscles of his shoulder, that his Right arms is rendered almost useless to him in his

Business and by the fracture of

his under jaw the power of Mastecation is totally destroyed and by his, low Slop diet, weakness, and total loss of his right arm, and the running of his wound, his Situation is rendered truly Pitiabale being unable to Contribute any thing to the Support of a wife and five small Children but is rather a Burden upon them, & has no Encouragement from his Surgeon of his being Materialy better He therefor is under the disagrable Necessity of begging relief & assistance of this Honrable Court by a Pension or other wise as your Honors Great wisdom & compations may suggest, and your

Petitioner as in duty bound will Ever pray

Lexington 14th June 1776

John Robbins"³²

Not only does the petition describe his ghastly wound, but he had a wife and five small children all under the age of 13 to support. For the 1776 petition, Robbins is given a pension for the year:

"The Committee on the Petition of John Robbins have heard The Petitioner Examined his wounds considered his deplorable Circumstances and Report by way of Resolve----

In the House of Representatives Nov 4th 1776--Resolved that there be allowed and paid out of the Publick Trsy to and for the use of the Petitioner John Robbins the sum of thirteen Pounds six Shillings and Eight pence yearly untill the General Court Shall otherwise Order it, to Recompence him for hid sufferings by wounds which he recd on the 19th of Aprill 1775"

He submitted petitions with the same wording until 1778 when he has another addition to his family, a daughter named Hannah. This time his petition also included a note from his doctor. It seems his body was never going to recover from his awful bullet wound from the morning of April 19 (Figure 13):

"To The honorable Council of the State of Massachusetts Bay. This Certificate humbly sheweth that the Bearer Mr John Robbins of Lexington receiv,d such a greivous Wound thro: the Muscles of his right shoulder Neck & Jaw Bone which last was miserably fractured: by which Wound the unhappy Man is yet so debilitated in his right shoulder that He is unable to perform but very little labor as Fatigue upon his small Farm for the support of a numerous Family of young Children and in the Opinion of the Subscriber who was his surgeon He is unhappily like to remain in such a weakned hopeless Condition during life and is a proper Object of the gracious Bounty of this State-----

Watertown July 5th .1778 sign,d Marshall Spring

N.B. He was wounded in the Morning of the

19th of april 1775 at Lexington"³⁵

Robbins continued to petition yearly for a pension through the war and did receive money from the state. The last listing found for him is in a newspaper article with a list of pensioners stating that a July 8, 1786, resolve of the courts placed him on a list of pensioners that the commonwealth felt could do garrison duty. He was to appear at the Commissary of Pensions for a revue.³⁶ After this date there does not seem to be any other info on John Robbins. But what about his wound?

To the Honorable the Colony Council & the House of Representatives in general Court assembled

The Petition of John Robbins of Lexington humbly sheweth, that your Petitioner was on the memorable 19th of April 1776 most grievously wounded, by the British troops in Lexington, by a musket ball which pass'd by the left of the spine between his shoulders through the length of his neck making its way through and most miserably shattering his under jaw bone, by which a dangerous wound your Petitioner is so much hurt in the Muscles of his shoulder, that his right arm is rendered almost useless to him in his business and by the fracture of his under jaw the power of Mastication is totally destroyed and by his low stop diet, weakness, and almost total loss of his right arm, and the running of his wound, his situation is rendered truly pitiable being unable to contribute any thing to the support of a wife and five small children but is rather a burden upon them, & has no encouragement from his surgeons of his being materially better He therefore is under the disagreeable necessity of begging relief & assistance of the Honorable Court by a Pension or otherwise as your Honors great wisdom & Compassions may suggest, and your Petitioner as in duty bound will ever pray
Lexington 14th June 1776

Figure 12. June 14, 1776, petition from John Robbins describing his horrific wound. Massachusetts Archives Collection.

To The honorable Council of the State of Massachusetts Bay. This certificate humbly sheweth that the Doctor Mr John Robbins of Lexington received such a grievous wound thro: the Muscles of his right shoulder Neck & Jaw-bone which last was miserably fractured: by which wound the unhappy Man is yet so debilitated in his right shoulder that he is ^{able} to perform but very little labor's Fatigue upon his small Farm for the support of a numerous family of young children and in the Opinion of the Subscriber who was his surgeon He is unhappily like to remain in such a weakened hopeless condition during Life and is a proper Object of the gracious Bounty of this State
Watertown July 15th 1776 Signed Marshall Spring

N.B. He was wounded in the Morning of the 19th of April 1776 at Lexington

Figure 13. July 5, 1778, note from Watertown doctor Marshall Spring regarding John Robbins' wound. Massachusetts Archives Collection.

John Robbin's petitions graphically describe the horrific wounds he suffered to his back, neck and mandible on Lexington Green, April 19, 1775. Could a single musket ball have done such extensive damage to cause him partial nerve damage in his arm and broken his jaw to the point of only being able to eat "low slop?" Or might he have exaggerated the effect of his wounds to obtain a larger compensation from a sympathetic audience?

Military surgeons in the late 18th and well into the 19th century described and commented on treating gunshot wounds in a variety of texts and treatises. A perusal of some of these texts as well as the pertinent sections of the Medical and Surgical History of the War of the Rebellion³⁷ (Part One, Volume 2 and Part 2, Volume 2, 1875 and 1877 respectively) for wound effects of .69-caliber musket balls clearly demonstrate that these large lead balls could indeed inflict significant and lasting effects to hard and soft tissue as well as nerves. Once a ball enters the human body it can be deflected from a straight path through the tissue by any number of factors and exit the body after a torturous route. This is borne out by our recent live-fire studies of colonial-era weapons, particularly with the shooting of the Brown Bess muskets. We observed, using high-speed video recording, that a .69-caliber ball shot at a target 25 to 30 yards away had velocity and energy significant enough to pass through reproduction clothing and 32 inches of tissue simulant. That is the equivalent of the body mass of two people. The ball, on exiting the tissue simulant, still had enough velocity and energy to travel between 50 and 100 additional yards before reaching its terminal velocity.

John Robbins' pension account of his wounding provides additional clues as to why he suffered such extensive wounds. Robbins states he was in the front rank of the Parker's militiamen drawn up on Lexington Green. His account states the company started to disperse when the British regulars were ordered to fire. Assuming the accuracy of his account he may well have turned so that his back was partially toward the British line. On hearing the firing begin he may have instinctively ducked or bent forward so that the ball struck his upper right back near the spinal column. If slightly bent over, as is speculated, the ball could well have been deflected by muscle. Such deflection is consistent with the ball passing near the spinal column and traveling up the neck, shattering his mandible, and exiting the body. Robbins' right arm paralysis is consistent with bullet-caused nerve damage, as is the damage to his jaw that no longer allowed him to chew his food. His note that the wound was still "running" suggests that his wound had not fully healed, and he suffered from a residual infection. Perhaps some cloth bits or other foreign matter were still in the wound causing it to continue to fester and discharge up to at least 1776. He is lucky to have survived his wounds at all given the state of medical knowledge and treatment of the day.

The validation study employed a Clear Ballistics Loaded Ballistic Gel Bust. The busts are created using human tissue simulant gel and synthetic bone. The purpose of the product is for testing ballistics, weapons, and protection. The gelatin is made from high-quality, transparent, synthetic gelatin and offers the same mechanical properties as animal gelatin and contains a synthetic spinal column, mandible, and skull which is filled with synthetic blood.

The bust was placed on a platform with back area raised using crumpled plastic sheeting (Figure 14) in order to simulate a person who is slightly bent over. The shooter used a faithful reproduction

Pattern 1756 "Brown Bess" musket of .76-caliber and a spherical lead ball of .69-caliber weighing 33.5 grams.

Archaeologist Jay Waller, the shooter, fired the one and only shot at the gelatin bust from a bench rest position. The shot struck the gelatin bust at 845 f/s (256.5 m/s) in the right upper shoulder area. High-speed videography (Figure 15) shows the bullet passed through the shoulder, probably striking the flat part of the shoulder blade, if it had been present in the bust, passing up along the right side of the neck, then striking the lower jaw or mandible at the gonial angle (lower back edge of the mandible) shattering it into more than 30 pieces. The jaw broke at the center line into two large pieces and ten other smaller fragments which were used to reconstruct the jaw. The right condyle and ascending ramus were shattered. The many small synthetic bone pieces recovered in the gelatin are fragments of the gonial angle area that could not be completely reconstructed. The skull itself suffered extensive damage with the lower rim of the right eye orbit being fractured as well as most of the zygomatic arch. High-speed video shows the impact of the ball as it struck the jaw and passed through the gelatin. The video shows a fracture on the skull initiating in the sphenoid and temporal area and radiating upward into the right parietal area. The fracture is 5 inches (11 cm) long. Unfortunately, the ball was not recovered as it entered the backstop outside of our target area and could not be found.

Wounds to the lower jaw are not new, nor are studies to determine the effect of bullets to the jaw. A classic study by an army officer and physician in the early 20th century, Col. Louis LeGarde, observed that bullet wounds to the lower jaw were often accompanied by fracture of the ascending ramus and neck of the condyle as well as comminution of the bone. This, upon healing, caused ankylosis unless properly treated in time.³⁸ This early 20th century lower jaw bullet impact and effect to the face and bone is consistent with that described in Robbins' petitions.



Figure 14. Joel Bohy positioning the bust and aligning the shot angle for the shooter.

The high-speed videography clearly shows the ball's passage through the gelatin and the mandible being shattered into many small and some larger pieces. The skull also exhibits impact damage from the kinetic energy being dispersed as the ball passes



Figure 15. Top left: The ball created a splash effect as it enters the gelatin bust. Center top: the ball exiting the ballistic gelatin bust. Note the massive cavitation effect on the neck and lower jaw area. Top right: the bust after the immediate cavitation ceased. The red areas are synthetic blood oozing from the fractured skull. Bottom: The synthetic skull and bone fragments removed from the gelatin bust.

through the gelatin. The lower eye orbit is shattered and cracks in the right parietal initiate quickly and continue up into the temporal area. The bullet path was photographed with an ersatz trajectory rod to show the bullet path. We believe this shot and its resulting damage to the mandible and skull is illustrative of the power of the British musket's ability to incapacitate a foe. Whether the wound path and damage is entirely consistent with John Robbins' wound is a matter of conjecture, but it is likely close given the description of wounds in surviving documentary records.

Conclusions

In our first two live-fire studies, we focused on the muzzle velocity of Revolutionary War-era small arms. In this study, our focus was more on the velocity of a spherical ball as it struck an object, as well as the damage done to the objects in order to try to replicate the damage observed on surviving bullet-struck artifacts from the first day of the American Revolutions, April 19, 1775.

The December 2023 firearms live-fire experiment can be characterized as an unqualified success. The intent behind the investigation was to determine the external ballistic bullet performance of a British Pattern 1756 Long Land smoothbore musket on a specific series of targets. The general premise and research design that drove the experimental investigation was to document the fired ball performance in terms of strike velocity, penetration capability,

and bullet deformation as it terminated its flight. This study not only recovered bullets fired at different media; tissue simulant and soil; it also used high-speed videography to determine initial strike velocity for each shot. The collected information was analyzed and compared to known and documented surviving bullet-struck artifacts.

Our data exhibits excellent correspondence with other ballistic performance models of Brown Bess muskets, further validating those models and allowing us to compare our data findings with various data sets. The shots fired at replica house walls, interior panels, window shutters, colonial powder horns, and a ballistic gelatin bust very closely duplicated the documented bullet strikes surviving from April 19, 1775. The experimental effort also demonstrated, albeit with a small sample, that many cloth impressions on spherical balls originated from passing through clothing. These data are only relevant to balls that are not patched.

The work we undertook was designed to aid archaeologists in gaining a better understanding of the potential information yields that can be gained from bullet analysis from archaeological sites. We have focused on one conflict zone, the British retreat route from Concord to Charlestown on April 19, 1775. The shooting incident live-fire study validated the external ballistics of the firearms and their penetrating power.

The validation study clearly demonstrates that the British Brown Bess musket had the capability to penetrate various media that is observed in the surviving architectural elements and objects. The study data is important information that expands and enhances our understanding of large caliber smoothbore musket performance and verifies their strike capability. The data also support and enhance the interpretations of the surviving bullet-struck artifacts for professional historians, archaeologists, and the public alike.

For more information on the study see *Bullet Strikes From the First Day of the American Revolution*¹⁷, Andrew Mowbray Inc. - Publishers, Woonsocket, Rhode Island. <https://gunandswordcollector.com/product/bullet-strikes-american-revolution/>.

Acknowledgements

The authors are indebted to the generosity of the American Society of Arms Collectors Foundation. We would also like to thank Stuart C. Mowbray, Jay Waller, Jonathan Cook, John Beck, the Whitinsville Fish & Game Club, Matthew Burbank, Lisabeth Palmer, Joseph Balicki, Anna and Neil Rasmussen, Joel Dukes, Minute Man National Historical Park, Acton Memorial Library, Aimed Research, Arlington Historical Society, and the Massachusetts State Archives for their kind assistance with this research project.

ENDNOTES

- ¹ American Antiquarian Society, United States Revolution Collection, 1754-1928, Box 1, Folder 18.
- ² Letter from Richard Lechmere to an unknown recipient, Dr. Gary Milan Collection.
- ³ *OPENING OF THE WAR OF THE REVOLUTION 19th of April 1775. A BRIEF NARRATIVE OF THE PRINCIPAL TRANSACTIONS OF THAT DAY BY JONAS CLARKE PASTOR OF THE CHURCH IN LEXINGTON.* Appended to a sermon preached by him in Lexington, April 19, 1776, *LEXINGTON, MASSACHUSETTS*, THE LEXINGTON HISTORICAL SOCIETY, 1901, p. 1.
- ⁴ Hancock note to Gerry, Dr. Gary Milan Collection.
- ⁵ *A Narrative, of the Excursion and Ravages of the King's Troops Under the Command of General Gage, on the nineteenth of April, 1775: Together with the Depositions*, Massachusetts-Bay: Worcester: Printed by Isaiah Thomas, by order of the Provincial Congress, 1775.
- ⁶ Account of Thaddeus Blood, *Boston Daily Advertiser*, 4/20/1886.
- ⁷ Ibid.
- ⁸ *The Concord fight: An account by Amos Barrett: the personal experiences of the author, who participated in the fight*, Privately Printed, 1924.
- ⁹ Account of Thaddeus Blood, *Boston Daily Advertiser*, 4/20/1886.
- ¹⁰ Ibid.
- ¹¹ *American Archives*, Series 4, Volume 2, pp. 630.
- ¹² Letter from an Unknown Officer, Dr. Gary Milan Collection.
- ¹³ Massachusetts Archives Collection, Volume 138, p. 371.
- ¹⁴ Ibid, Volume 180, p. 196-197.
- ¹⁵ *Three Military Diaries Kept by Groton Soldiers in Different Wars*, Samuel A. Green, University Press, 1901, p. 83.
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- ²⁴ *The Harvard Register*, 1827-28, pp. 112-113.
- ²⁵ *Boston Daily Advertiser*, 4/28/1835.
- ²⁶ *Lowell Daily Citizen and News*, 8/12/1870.
- ²⁷ *Ibid*, 9/6/1870.
- ²⁸ *Springfield Republican*, 4/21/1871.
- ²⁹ *Boston Journal*, 4/20/1887.
- ³⁰ *Ibid*, p. 249.
- ³¹ National Archives.
- ³² 1st Petition of John Robbins, Massachusetts Archives Collection, Muster Roll Volume 70, p. 327.
- ³³ Lexington, Mass., Record of Births, Marriages, and Deaths to January 1, 1898, Boston, Wright & Potter Printing Company, 1898, p. 66.
- ³⁴ *Ibid*.
- ³⁵ Certificate from Dr. Marshall Spring for John Robbins, Massachusetts Archives Collection, Volume 230, p. 134.
- ³⁶ *American Herald*, January 15, 1787.
- ³⁷ United States Surgeon General's Office, *Medical and Surgical History of the War of the Rebellion*, Washington, G.P.O. 1870-88.
- ³⁸ LeGarde, Louis A. *Gunshot Injuries: How they are inflicted, their complications, and treatment*, 1991 (reprint of 1916 edition), Lancer Militaria, Mt. Ida, AR, pg. 202. Similar tissue and skeletal damage are also described in the *Medical and Surgical History of the War of the Rebellion* volumes for Civil War-era gunshot injuries to the face.

