The Effects of Firelapping on Forensic Handgun Identification

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ABSTRACT:

Firelapping is a process utilized primarily by competitive shooters to improve the accuracy of their barrels. The process involves firing a sequence of bullets that have been coated with increasingly fine particles of grit suspended in a lubricant base through the barrel to polish out imperfection in the metal. To test the effect of firelapping on individual characteristics in the barrel, five guns were firelapped. Test fired bullets fired after the process were compared to those fired before. The post firelapping bullets showed significant reductions in previously prominent striae and gross marks, as well as the addition of characteristics and the modification of the appearance of other features. The firelapping process effectively removes a significant amount of the individual characteristics from the barrel, such that bullets fired after the process may be found to be an inconclusive match to those fired from the same gun before.

Introduction:

When barrels are manufactured, the reaming and rifling of the barrel leaves behind a unique compilation of imperfections in the metal. These can take the form of sharp edges on the lands, tiny burrs of metal left behind, and striations corresponding to the surface of the tool used on the barrel (1). Bullets traveling through the barrel encounter these and pick up minute deformations on their surfaces, which produce individual characteristics on the bullet surface, allowing for the microscopic identification of the source barrel (1). These imperfections in the barrel will also negatively affect the development of stable gyroscopic motion and increase the friction the bullet encounters, reducing its velocity (2).

In the process of lapping, these imperfections are removed or reduced from the surface of the bore, resulting in an increase in the accuracy of the barrel (3,4). Hand lapping, also called tapping, involves forcing a lead slug, which has been coated with fine grit abrasives, through the barrel several times. This effectively polishes out most of the imperfection from the bore and removes sharp edges from the lands. This method of lapping is expensive, time consuming, and must be done by the manufacturer or a gunsmith, limiting the use of the process to mainly competitive shooting barrels (4,5).

Barrel manufacturers have been intermittently experimenting with the idea of giving a final postproduction polish to their barrels using a more rapid and low cost process, known as pressure or firelapping, for over a hundred years (5). Firelapping involves firing a series of bullets that have been coated with increasingly fine grits through the barrel. The bullet bearing surfaces act like the hand lap slug, progressively smoothing and polishing the inside of the barrel as they travel through it (3). Until recently, it was not possible to consistently obtain the desired results of a more accurate barrel. Inconsistencies in grit particle sizes would sometimes result in increased surface roughness or cause the removal of excessive amounts of metal. The ideal surface roughness, the fluctuations in the heights of the individual grains of metal that form the surface, for firearms is typically between 10 and 20 micro inches (0.000001-0.000002 inches). If the barrel is over polished, there will be greater surface contact between the bullet and the bore, increasing the friction encountered, slowing the flight of the bullet and reducing accuracy (6). Excessively rough barrels also create increased friction and loss of velocity and accuracy. To produce the proper surface roughness through firelapping, the abrasives used must be of very strict tolerances in particle size and they must be evenly distributed on the lap bullet to attain the desired effect and not damage the bore (3,5). Due to improved quality control in lapping compounds, current firelapping kits produce fairly consistent results. This has increased their acceptance in the shooting community in recent years. The resulting barrels can have an increase in accuracy of anywhere from a 15% to 60% improvement in group sizes (4,5).

Firelapping kits include anywhere from 3 to 5 abrasive particle sizes for use in succession from roughest to finest grit. Most kits provide the compounds as gels for self-application to metal jacketed bullets. These gels are a mixture of fine abrasive particles in a lubricant base, which is applied evenly across the bullet and allowed to dry. The lubricant is often a very light oil or paraffin which allows for fluidic movement

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.40 caliber Taurus demonstrating agreement on the ends of a groove in two pre-firelapping test fires.

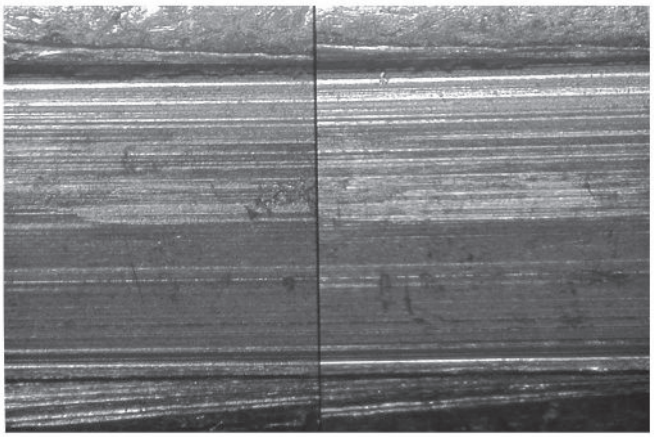
of particles as they pass through the barrel. The lap itself can be silicon carbine, aluminum oxide or carborundum, etc.; any fine abrasive particle that has uniform particle sizes (5,7). Most kits start with a selection of coarser grits, such as #220, #400, and/or #600, and finish the lap with very fine grits, such as #800 and/or #1200 grit (5). Bullets are chosen which have long bearing surfaces, ensuring that there is maximal contact between the abrasives and the bore, increasing the amount polishing produced by each individual bullet (4).

Several firelapping kits advertise that the process is able to either eliminate or significantly reduce the toolmarks and imperfections in the bore (5,4). As these are what create the individual characteristics that are identified on bullets fired through the barrel, if these products achieve what they claim, they would alter the individual characteristics left on bullets fired subsequent to lapping. In order to study the effects of such kits on the individual marks left on bullets, 5 firelapping kits were purchased. Some of the kits currently on the market are Final Finish, SKS, NECO, and LBT. The David Tubb's Final Finish System ™ by Superior Shooting Systems Inc. firelapping kits were chosen for use in this study, as they include factory-coated lap bullets. Factory coating ensured a greater consistency in abrasives density and distribution on the bullet surface over self-application products (4). Five guns (1- .38 Special, and 2 each of .40 and .45 calibers) were selected and cleaned. Ten test fires were taken from each. The firelapping procedure was then followed according to product instructions. After the procedure, ten additional bullets were collected from each gun and compared microscopically to the bullets fired before the firelapping.

Procedure:

Five Final Finish (Final Finish System by Superior Shooting Systems Inc. 801 N. Second St. Canadian TX 79014) firelapping kits (one .38 /9mm, 150 gr. bullet kits; two .40/10mm, 180 gr. bullet kits; two .45, 230, gr. bullet kits) were purchased from a gun supply catalog. The kits contained 10 bullets in each of 5 different grits. The lap bullets were reloaded into stock ammunition: UMC (Remington Union Metallic Cartridge Company) .38 Special 158 grain lead bullet cartridges (No. L38S5) and Federal (Federal Cartridge Company) full metal jacket American Eagle Ammunition .40 S&W cal 155 gr. bullet (No. AE40RZ) and .45 cal 230 gr. bullet (No. AE45A). The lap bullets were downloaded approximately 10%, as per the kit instructions. (4) The abrasive compound on the surface of the bullet increases the chamber pressure, making downloading necessary. (3) The bullets were seated to an overall cartridge length consistent with factory loads. (4) The reloading equipment utilized included a Quinetics Ultimate Model kinetic bullet puller (Quinetics Corporation, San Antonio, TX), a RCBS press (RCBS Omark Industries, Lewiston, ID) and Redding Reloading Titanium Carbide Dies and shell holders (Redding Reloading Equipment, Cortland NY).

Five guns of corresponding calibers were selected from the NYPD reference library. The guns utilized were a .38 Spl. Colt Official Police PT model, a .40 cal Star Firestar model, a .40 cal Taurus PT100AF model, a .45 cal Star PD cal 45 model, and a .45 cal Colt Double Eagle Series 90 model. The guns were cleaned using GunScrubber (Birchwood Casey



.40 caliber Taurus demonstrating agreement in the middle of the same groove two pre-firelapping test fires.

GunScrubber Solvent/Degreaser, Birchwood Laboratories, Eden Prairie, MN) and cotton swabs. Ten test fires using Federal full metal jacket ammunition were taken from each gun. The test fires were made into a water recovery tank.

Following kit instructions, the bullets from each compound, working from the coarsest compound to the least, were fired in sequence through the barrel. Between each set of ten bullets, the barrel was cleaned with GunScrubber, a brass bore brush and cotton swabs. The copper and lead that builds up between shots of the lapping bullets has to be removed to increase the effectiveness of the kit, as the process requires a clean bore (4). After the process, the barrel was cleaned once more. The entire firelapping process took approximately 2-3 hours per gun from start to finish.

After the firelapping process was completed, ten test fires using Federal full metal jacket ammunition were again taken from each gun using a water bullet recovery tank. Each set of test-fired bullets was indexed to ensure identification amongst those of the same group. The pre-firelapping bullets were then compared to the post-firelapping bullets using a comparison microscope.

.40 caliber Taurus demonstrating agreement on the ends of a groove when comparing pre (left) to post (right) firelapping test fires

Results:

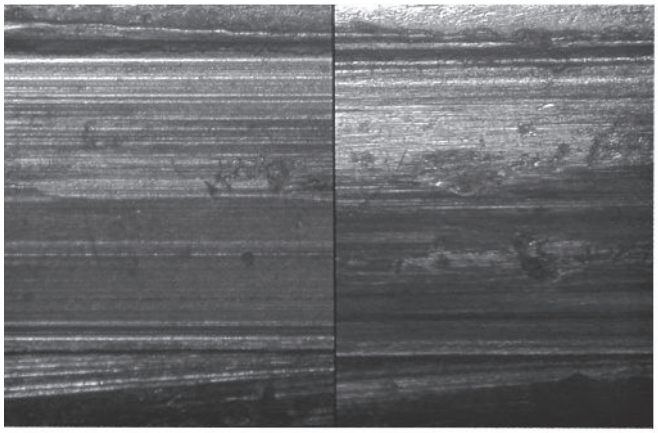
The .38 Spl. Colt produced very fine stria characteristics prior to firelapping. On the post firelapping test fires, the majority of stria were erased and replaced by novel, fine stria that had different appearances and locations. The pre to post firelapping bullets were found to lack corresponding individual characteristics and could not be aligned to each other. If this case were encountered, the bullets would be found inconclusive.

The .40 cal Star had both heavy and fine stria on the lands and grooves. The post firelapping test fires showed a significant reduction of the heavy characteristics and a loss of the fine stria. The grooves could be aligned, though the features used to do so were different from those used to index the bullets. Previously prominent marks were either not there or they were not visible in the same way. Correspondences were still identifiable, though there were many differences. Marks that did remain were mostly present at the heel of the bullet, but the correspondences were lost as they were followed toward the nose. A notable change on the post firelapping bullets was the formation of a deep arching striation in one of the bullet grooves that was seen as a light, much less extensive mark prior to firelapping. Slippage was also seen in the post firelapping test fires. The individual characteristics of this gun were significantly reduced by firelapping. If this case were encountered, the bullets would be found inconclusive.

The .40 cal Taurus produced heavy and medium intensity stria on the lands and medium intensity stria on the grooves in the pre firelapping test fires. These were easily identifiable to each other, while the post firelap test fires were not easily identified to each other due to fewer characteristics present. There was a significant reduction in the individual characteristics but several individual characteristics remained. Some of the individual characteristics were made more prominent. The test fires still retained a number of individual marks that were consistent between pre and post test fire samples. If this case were encountered, the bullets would be identified as a match.

The .45 cal Star had a worn barrel prior to firelapping. The pre test fire bullets exhibited some slippage and were difficult to index. Only 9 of 10 could be conclusively identified to the others. The barrel produced lots of fine stria with some of medium intensity. The post firelap bullets exhibited lots of slippage and had a washed off appearance towards the nose. The individual characteristics were decreased to a degree where the corresponding areas could not be determined on the pre to post bullets. There was a significant lack of correspondences on the pre to post bullets. If this case were encountered, the bullets would be found inconclusive.

The .45 cal Colt had fine and medium intensity stria prior to firelapping. There was a definite change seen in the pre to post test-fired bullets. However, a number of individual characteristics carried over. If this case were encountered, the bullets would be identified as a match.



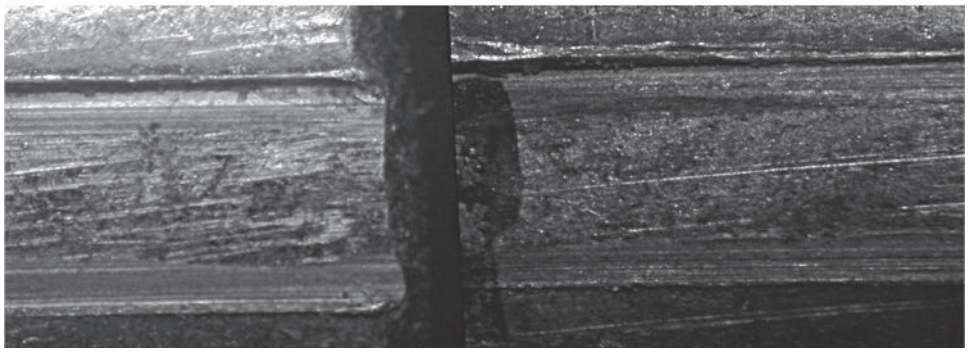
.40 caliber Taurus demonstrating a lack of agreement in the middle of the same groove when comparing pre (left) to post (right) firelapping test fires

Discussion:

Firelapping is widely available and marketed as a quick, do-it-yourself method of barrel alteration. Without the cost restrictions associated with hand lapping, the process of firelapping is now available to anyone with access to reloading equipment. Firelapping kits are relatively inexpensive, averaging in price from $30 to $80 U.S.C. While marketed mainly towards rifles, kits are available for pistol and revolver calibers. Any barrel can be lapped at any time, though it is designed for those wanting to improve the accuracy of their firearm.

Lapping polishes the inside of the barrel, removing a thin layer of metal and creating a smoother finish. The process is designed to remove less than three ten thousandths (.0003) of an inch of metal from the bore. The product advertising claims that in doing so, the bore diameter becomes more uniform and that the polishing will leave only a few of the deeper toolmarks on a reduced scale (4). This corresponds with the results obtained in this study. The stria seen as heavy or medium in intensity had a greater likelihood of remaining after the firelapping procedure, though they were greatly reduced in appearance. The mechanisms creating the fine stria would also be fine in nature and so more readily polished away than more prominent imperfections in the barrel. This process effectively reduced the imperfections in the bore, as seen by the significant reduction in the individual marks left on post firelapping bullets. It did not, however, remove all individually identifying features.

In addition to removing many of the individual characteristics from the barrel, firelapping also created new characteristics that either were not there before or were altered in appearance. As the process alters the dimensions of the barrel, this could be due to a change in contact dynamics as the bullet passes through the barrel. The grooves appeared less deep after firelapping the bore, which may allow the bullets to ride in the rifling slightly differently, increasing contact in some areas and decreasing it in others. Changing the alignment of the bullet in the barrel would affect the manner in which the imperfections remaining after firelapping cut into the bullet surface to create stria, changing the appearance and intensity of the marks. The lapping bullet could also leave toolmarks behind in the barrel. The abrasive coating makes it become a polishing surface like a file, which leaves individual marks behind. New striations were noted on the post firelapped bullets. This is consistent with findings in a past study by Lucien Haag on the use of firelapping kits in guns with polygonal rifling. In this study, the firelapping also resulted in the production of novel individual marks, which then allowed the polygonal barrels to be identified (7).



.40 caliber Star demonstrationg a novel, deep arching striation in the post firelapping test fire (right) that was not present with the same intensity on the pre-firelapping test fires (left)

Conclusion:
Firelapping caused a significant loss of individual characteristics from the barrel. The effect was more profound on the finer stria. Firelapping also created or changed the appearance of some remaining characteristics. Firearms examiners should be aware that barrels that have been firelapped may no longer produce test fires readily matched to samples fired before the process.

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