Characterising “Street Knives”: A Study of the Tip Sharpness and Penetration Forces for Common Bladed Weapons

A, H Jones[1], I. Elomari[1] and J. Barnes-Warden[2]

[1]*Materials and Engineering Research Institute, Sheffield Hallam University, Howard St, Sheffield, S1 1WB, UK. a.h.jones@shu.ac.uk*
[2]*The Metropolitan Police Service, Physical Protection Group, 60 Albany St, London, NW1 4EE*

Abstract. Data published by the United Kingdom’s Home Office (UKHO) details the annual number of UK offences with a knife or sharp implement rose by 44% between 2011 and 2019. Knife crime is prevalent in London, and the knife threat to frontline police officers is significant. It is therefore essential that the threat from “real” blades is defined, and the range of threats present on the street is understood. In order to understand the wide range of real knives typically carried on the streets of London, this paper evaluates a large quantity of knives (n=66) confiscated by the Metropolitan Police. These confiscated knives were compared with new, shop bought, kitchen knives, and the engineered blade (P1B) from the UKHO body amour standard 2017. The penetration capability of the weapons has been measured using quasi-static testing by measuring the forces required to penetrate skin simulants (silicone rubber and foam) formerly used and characterised in forensic studies. These results have been evaluated for correlations between physical parameters, such as tip angle and tip radius, measured using macro-photography and electron microscopy. The lowest force to perforate the skin simulant was recorded for the P1B engineered blade (0.18 kgf). Four new (33% of sample) and four confiscated (6% of sample) knives perforated the skin simulant with less than twice the force required by the P1B. However, the majority of confiscated knives (66% of sample) required more than five times the force of the P1B to perforate the skin simulant. From this data, we have determined a moderately good correlation between the tip geometries of the knives and the loads required to penetrate the skin simulant. The penetration load, L_P, of the skin simulant is proposed as an easily determined and quantifiable measure of knife tip sharpness. Knowledge of the range of sharpness of street knives can be used to assist in future armour design, especially for coverage of hard to protect areas of the torso, head and neck.

1. INTRODUCTION

Data published by the UK Home Office shows that the annual number of UK offences with a knife or sharp implement rose by 44% from 33,669 incidents in 2011 to 47,136 in 2019 [1]. Knife crime is particularly prevalent in London with 179 police recorded crimes per 100,000 population, double the national average for England [2]. In 2019 eighty six fatal stabbings were recorded, many of which are linked to gang violence [3]. Hence, the knife threat to frontline police officers is significant, and therefore it is essential that the threat from “real blades” is defined, and the perforation characteristics are understood. There is also a constant drive to increase the coverage of protection while not overburdening the wearer or making them less effective.

The parameters governing the penetration force of a knife would seem to be related to the knife tip geometry but to date no published study has shown a good correlation between the force required for a knife tip to penetrate in a stabbing action and the geometry of the knife tip. There is also no clear agreement on which parameters relating to the knife tip are most important and how they should be measured. Typically, the “tip angle” the “tip radius”, “blade thickness” and the blade’s “cutting angle” or “edge angle” are used but these are not universally recognized or defined.

A number of papers have used a limited range of typical bladed weapons such as kitchen knives and determined the forces required to penetrate human cadaveric tissue, simulated human tissue or porcine tissues. A good summary is given by Annaidh [4] and is summarized below in Table 1[1]. There were differences noted between quasi-static tests (QS in table, speed = 0.1 $m.s^{-1}$) and dynamic tests (D in table, speed = 1 $m.s^{-1}$ to 9.2 $m.s^{-1}$) and Annaidh shows that at higher dynamic test speeds of 9.2 $m.s^{-1}$ the penetration force was between 13 % and 20 % lower than the penetration force in quasi-static testing of porcine skin and polyurethane respectively. The penetration forces also varied with the knife type (cook’s, carving and utility) with the bluntest knife requiring 85% more force (2.4 kgf) to penetrate skin simulant than the sharpest (1.3 kgf). Much larger differences were observed for “blunt” weapons such as screw drivers and scissors with around 2 to 3 times the force required (2.5 kgf to 3.2 kgf) to penetrate polyurethane or porcine skin compared with the kitchen knives.

Nolan [5] measured the forces required for human participants to stab and penetrate skin simulants with 3 different knives. The knife geometry and the resulting forces for penetrating skin simulant are

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[1] Originally report as force in N they have been converted to equivalent loads in kgf for easier comparison with results given later in this paper and for understanding of said forces by non-scientists.

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shown in Table 2. Blunt weapons (screw drivers) showed around 4 to 5 times higher forces (63 N to 74 N). The data in the supplementary information for individual knives shows no meaningful correlation between knife geometry and penetration force. The large tip angles and the large standard deviations of +/- 20° from 5 individual knives of the same design is notable.

Hainsworth [6] showed a loose correlation between the "blunt edge radius" of several knives with varying tip geometries and the penetration depth of the knife when stabbing open cell foam with a fixed level of impact force. Below a blunt edge radius of 0.1 mm the penetration was up to100 % greater than knives with a radius > 0.2 mm. For radius from 0.2 mm to 0.7 mm there was no systematic variation in the penetration.

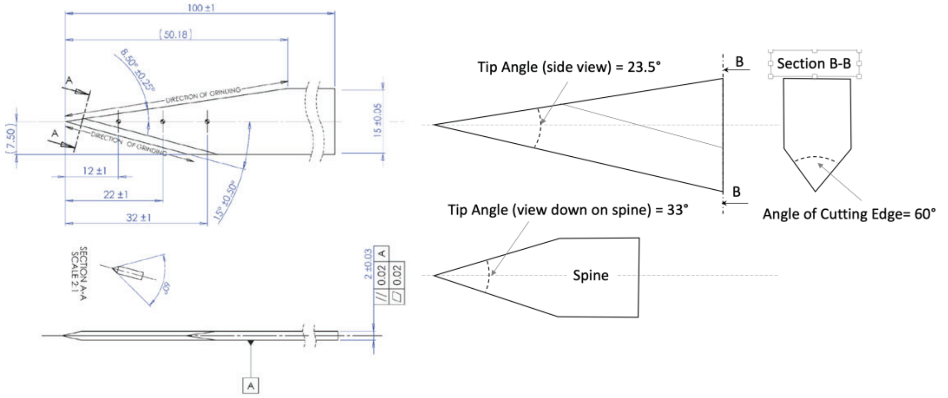
Nolan [7] also studied the ability of 3 types of kitchen knife to penetrate a skin simulant and several types of combinations of clothing (e.g. t-shirts, jeans, jackets). The three kitchen knives had tip angles of 64.8°, 74.1° and 103.5°, but the forces required to penetrate a skin simulant showed little difference (1.1 kgf, 0.97 kgf and 0.99 kgf respectively). However, when penetrating normal clothing the tip angle of 103.5° had a 20 – 30 % higher penetration force and tip angles of 64.8° and 74.1° tip angles showed similar forces.

Table 1: Summary of previous work on forces required to penetrate human and porcine tissues and synthetic materials, adapted from Annaidh (2013).

Test Method	Material Type	Penetration Forces (kgf)
QS, D	Cadaveric	<0.5 (sharp), 3 – 5 (blunt)
QS, D	Cadaveric	<1 (skin), 7 – 10 (clothing)
QS, D	Cadaveric	3.5 – 5.5
QS	Porcine	1.0 – 1.5
QS	Polyurethane (PU)	1.3 – 2.0
QS	Cadaveric, Porcine, PU	1.5 – 1.7 (QS), 1.0 – 1.2 (D)

Table 2: Knife type, Tip Angle and Skin Simulant Penetration Forces adapted from Nolan (2013).

Knife Type	Average Tip Angle, ° (SD)	Average Penetration Force, kgf (Standard Deviation)
All Purpose	120 (20)	1.2 (0.2)
Steak	120 (20)	1.9 (0.2)
Instrumented (Sabatier)	108 (-)	1.3 (0.1)



Steel hardness - Rockwell C = 52 – 55 (Vickers Hv30 ~ 550 – 650)

Figure 1: Extract from the engineering drawing of the UK Home Office P1B engineered blade and schematic close-up showing clearer view of tip angles

Assessment of knife resistant amour systems to UK Home Office (UKHO) standards [8] make use of the P1B engineered knife which is machine made blade with high tolerances on its dimensions as shown in Figure 1. It has a highly pointed tip with a tip angle in side view of 23.5°, in a view down on the spine of 33°, a cutting edge angle of 60° and is hardened to a high degree (H_{V30} ~ 600). It has clearly been designed to be a very high threat to the armour. However, data on how it compares in its penetration ability with the most common threats encountered "on the street", which generally have much larger tip angles, and/or rounded tips, but sharper cutting edges, has, to our knowledge, not been published. A test exists, developed by CATRA[2] in association with UKHO which uses a square section of silicone rubber (Shore A = 40) to determine the force required to push the point of a blade in to the rubber by a fixed distance. The P1B is deemed sharp enough if the force to do this does not exceed 4.5 N (0.46 kgf). However, this test is pass/fail test and does not quantify tip sharpness. Thus, there is a need for test that can accurately determine the "sharpness" of a blade and compare it to that of the standard P1B, while also simulating the materials in to which knifes typically are thrust.

Furthermore, it is of interest to have a statistical measure of the threat presented by the wide variety of "street knives" in the UK and how they compare to the P1B. Data on how the penetration ability of knives differs in terms of cost, quality, design and brand would be of significant interest, as would how such knives that have been in circulation for some time compare with new examples of such knives.

2. EXPERIMENTAL METHODS

2.1 Street Knives

In order to obtain a representative sample of bladed weapons of different types the UK Metropolitan Police Service (MPS) provided access to a large quantity (~2000) of confiscated weapons from which a selection was made that represented the typical range of such confiscated weapons. The choices made were guided by a number of MPS staff who had previously carried out statistical analysis of the types of confiscated weapons. In total 66 confiscated weapons were selected, a sample of which are shown in Figure 2. Additionally, 12 new kitchen knives of various designs and covering a range of costs and quality were purchased (Figure 3). P1B blades were obtained from the MPS or from the manufacturer[3]. A list of the knife categories with a brief description is given below in Table 3.

Table 3: List of Confiscated (C) and New (N) Knives by Type and Blade Length.

N or C	Knife Type	Blade Length (cm)	Description	Number
C	Kitchen - Chef	21 - 23	Wide blade	28
C	Kitchen - Carving	20 - 24	Narrow blade	11
C	Kitchen - Utility	10 - 14	Short narrow blade	7
C	Lock	9	Folding lock knife	7
C	Rambo	23	Large Combat Style	6
C	Combat/Survival	10 - 23	Narrow blade, double edge	3
C	Sword	45 - 47	Straight and "zombie" style	2
C	Filleting	15 - 21	Narrow and tapered	2
N	Kitchen - Chef	21 - 23	Wide blade	4
N	Kitchen - Carving	20 - 24	Narrow blade	4
N	Kitchen - Utility	10 - 14	Short narrow blade	4

Figure 2: Image of 24 of the 66 confiscated knives supplied by the MPS; Rambo (left), Kitchen (middle), Lock/Combat (right).

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[2] Cutlery and Allied Trades Association, Henry St, Sheffield, S3 7EQ

[3] High Speed and Carbide Ltd, Clough Bank, Off Edmund Road, Sheffield, S2 4EL

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Figure 3: The 12 new knives purchased for this analysis, 3 brands, 3 types of each brand. (grid on paper is 1cm x 1cm)

2.2 Knife Tip Measurement – Optical Methods

A photographic record of all knives was made and macroscopic images of the knife tips were taken for comparative purposes and to measure the side view tip angle (TA). Calibrated digital imaging software was used to measure knife tip geometries. Some examples are shown below in Figure 4. The tip angles (side view tip angle, TA) were measured for all knives at the scale shown in the examples in Figure 4. Where there was an obvious radius to the tip in this view, this was measured and recorded as the tip radius (R_T). Where no obvious flat, radius or damage existed at the tip its condition was recorded as "sharp" meaning it was essentially triangular on the scale of the optical magnification used (estimated $R_T < 0.1$ mm). Where there was an obvious round tip it was recorded as "rounded" and the approximate radius (R_T) measured in mm. Tip thickness was measured with a micrometer at approximately 1mm from the tip.

2.3 Knife Tip Imaging – Electron Microscopy

For safety and practical reasons the end 50 mm of blade was removed from the body of the knife. To observe the detail of the knife tips at higher magnification the ~ 50 mm knife tips were mounted for observation by scanning electron microscopy (SEM) and were observed in two orientations, (i) corresponding to the optical side view but with a slight tilt of the sample to observe the tip fully and (ii) looking down on the knife's spine at the tip to observe the spine tip angle and radius. (SA and R_S). The same magnifications or fields of view were used to capture photographs of the 3-dimensional form of the knife tips and to make measurements of the knife tip geometry using the calibrated SEM software.

2.4 Penetration Force Testing

The material penetrated by the knives was a skin simulant which gives reproducible results that are comparable with those of human skin [Nolan 2013]. A 2 mm thick sheet of silicone rubber with a Shore A hardness of 40 with a self-adhesive backing was adhered to a 100 mm x 100 mm x 100 mm cube of open cell foam[4]. The testing was carried out on a Universal Materials Tester (UMT-2) machine made by CETR (now Bruker) using a load cell with a maximum load of 10 kgf. The load cell and knife tip were located in the upper moving carriage and the skin simulant block was placed below and secured in place with double sided adhesive tape. The penetration speed used was 1 mm.s^{-1} and the travel of the knife (z) was set at 25 mm from the point of initial contact between the silicone and knife tip. Each knife was pushed in to the skin simulant block 5 times, each time in a new location. The load (kgf) and displacement (mm) were recorded during the entire loading cycle. The penetration load (L_P) of the skin simulant was judged as being the first significant event on the force versus displacement curve and was usually characterized by a drop in the force and a change in slope of the line after the event. For some sharp knives (e.g. the P1B) the event was small and hard to observe but nevertheless could be discerned by close inspection of the data. For some of the blunter knives no penetration occurred by a displacement of 25 mm and in these cases the displacement was allowed to continue up to a limit of 40 mm. Some blades did not penetrate even at 40 mm and the load cell reached its maximum value of 10 kgf as the foam was compressed. Average standard deviations from 5 measurements was +/- 7% of the load.

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[4] A01 polyether open cell foam, density = 23 to 28 kgf.m^{-3}, hardness 125 to 155 N, Acoustafoam Ltd, Shropshire

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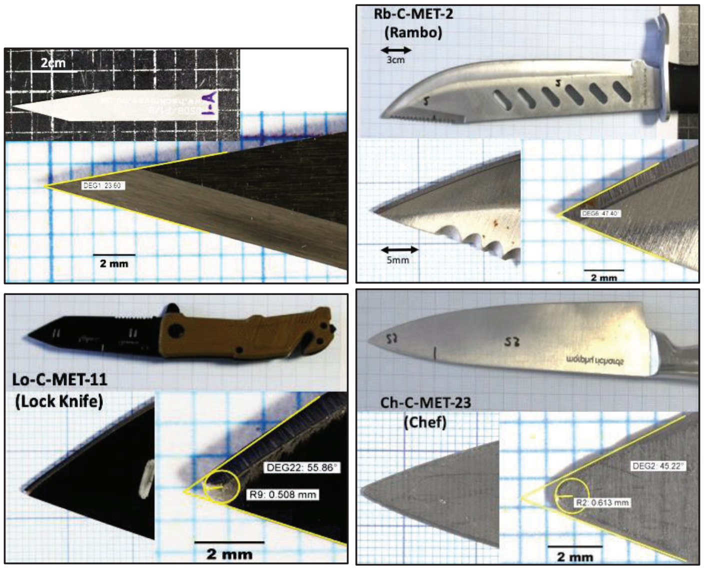

Figure 4: Photographs and macroscopic images of confiscated knives showing the measurement of tip angle (TA) and tip radius (R_T). P1B blade (top left), Rambo with sharp point (top right), Lock knife with rounded tip (bottom left) and Chef's knife with rounded tip (bottom right).

3. RESULTS

3.1. Optical Measurement of Knife Tip Geometry

The data for tip angle (TA), tip radius (R_T) and the blade thickness (t) at 1 mm from the end was measured for all 66 confiscated knives and all 12 new knives. Table 4 shows a comparison of TA and t for a selection of confiscated and new knives.

Of the 66 confiscated knives 23 were judged to be sharp (essentially triangular with $R_T < 0.1$ mm), 27 were judged to be rounded ($R_T > 0.1$ mm) and the remainder (16) were damaged, bent or truncated so that no meaningful measurement could be obtained. Figure 5 shows the distribution of tip angles (TA) for all sharp confiscated knives (23) and the distribution of the tip radius values for the round tipped confiscated knives (27). Of the 12 new knives 3 were judged to have rounded tips.

Table 4: Optically Measured Tip Angle and Tip Thickness for Confiscated (C) and New (N) Knives.

N/C	Knife Type (number)	TA (average), °	TA min/max, °	t (average), mm	t min/max, mm
N	Chef's (4)	55	49/60	0.5	0.5/0.60
N	Carving (4)	55	35/65	0.5	0.4/0.6
N	Utility (4)	52	42/72	0.5	0.4/0.6
C	Chef's (27)	54	33/80	0.7	0.4/1.1
C	Carving (10)	44	37/54	0.9	0.5/1.5
C	Utility (8)	42	30/60	0.7	0.4/1.2
C	Lock (7)	52	29/65	0.9	0.6/1.4
C	Rambo (5)	43	37/47	1.1	1.0/1.3

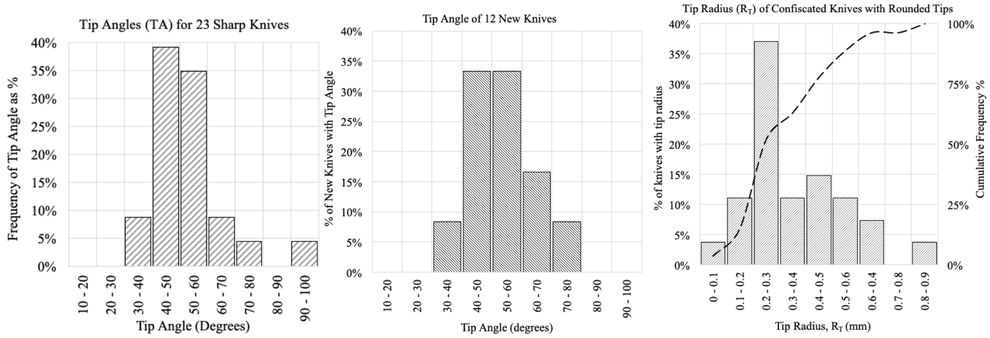

Figure 5: Distribution of Optically Measured Tip Angles (TA) for 23 confiscated, sharp knives (top left) and Tip Angle of 12 New Knives (bottom left). Tip Radius (R_T) of the 27 confiscated knives with rounded tips (bottom right).

3.2 Penetration Loads of Knives using Skin Simulant

The UMT instrument was used with all 66 confiscated knives and the 12 new knives as well as the P1B engineered blade. The distribution of L_p across all knives is shown as histograms in Figure 6. Some examples of the typical load – displacement plots that were used to determine L_p are shown in Figure 7. The average L_p for the P1B was 0.18 kgf +/- 0.014 kgf. Note that 11 of the confiscated knives did not penetrate at the maximum load of 10 kgf or maximum displacement of 40 mm. Across all confiscated knives L_p ranged from 0.31 kgf to 2.5 kgf which is between 1.7 and 14 times that of the P1B. Each knife style (e.g. Cooks, Carving, Rambo, etc.) showed significant variation, for example L_p for the 5 Rambo knives ranged from 0.39 kgf to 1.74 kgf (Figure 7 right). Confiscated kitchen knives had a large range and included some of the lowest (L_p = 0.32 kgf) and highest (L_p = 2.45 kgf) results.

New kitchen knives had a much narrower range of L_p than confiscated kitchen knives (0.3 kgf to 0.8 kgf) as shown in Figure 6 (right). For new kitchen knives, 100% had $L_p < 0.9$ kgf, with the majority (66%) having $L_p < 0.5$ kgf and the lowest L_p = 0.32 kgf. For confiscated kitchen knives, only 33% had $L_p < 0.9$ kgf and only 15% had $L_p < 0.5$ kgf but the lowest L_p measured was similar to the lowest L_p of the new kitchen knives. Of the 11 (16%) of confiscated knives that did not penetrate (DNP), the majority were the broken, bent or truncated at the tip.

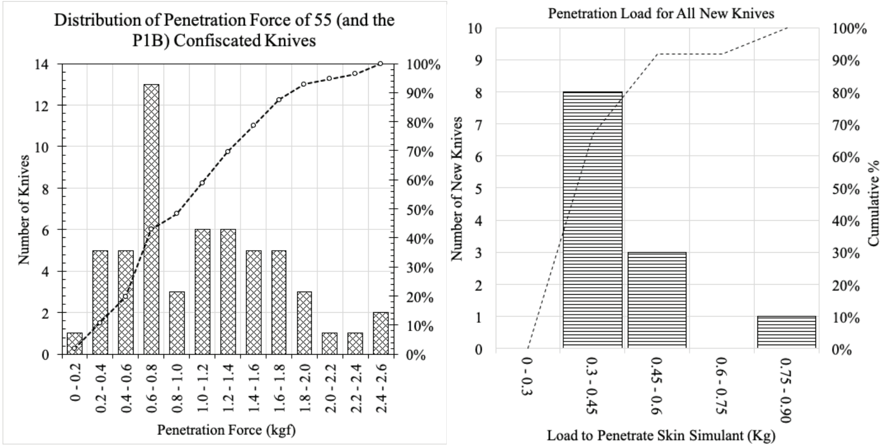

Figure 6: The distribution of the penetration force (L_p) for all confiscated knives (left) that penetrated. Data for new knives (right).

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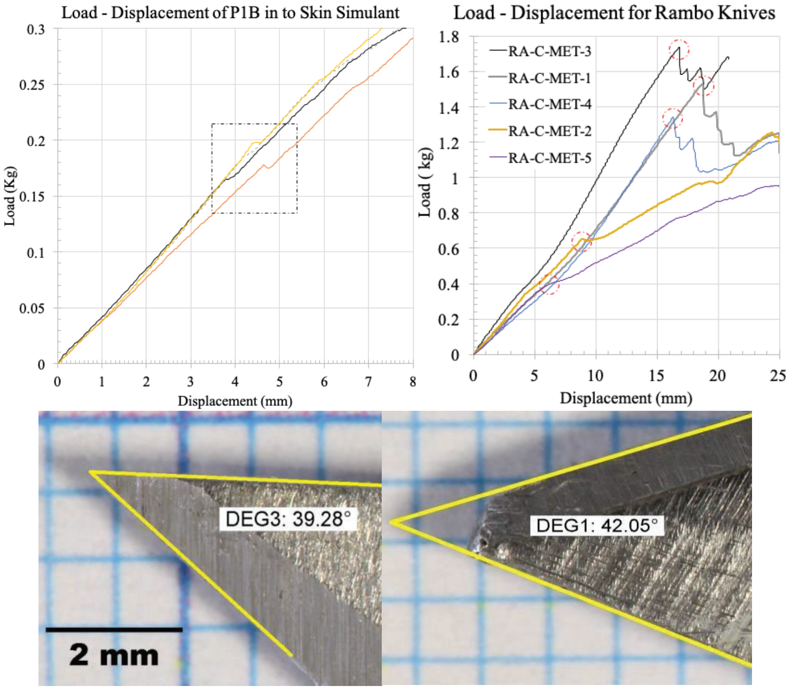

Figure 7: Examples of load – displacement data for P1B (top left) and 5 Rambo knives (top right) using skin simulant. P1B penetration load (L_p) is indicated by features within the dotted square. L_p for Rambo knives is indicated by dotted circles. Rambo knife tips with low (bottom left) and high (bottom right) values of L_p.

3.3SEM Imaging and Measurement of Knife Tips

Examples of the SEM images of the confiscated and new knives are shown in Figure 8. The tip geometries in SEM appear quite different from those observed using macro-photography (Figure 7) with differences in the measured Tip Angles and Tip Radius. In the SEM the Spine Angle (SA) and Spine Tip Radius (R_S) could be observed along with the way the cutting edge intercepted with the tip or did not reach the tip. All tips are different and have complex 3-dimensional geometries which are difficult to describe with 2 or 3 parameters. It was notable how the knife's cutting edge was rarely observed to extend all the way to the tip (top 0.2 mm) and so it plays a negligible role on the initial penetration of the knife tip. In cases where it did extend to the tip, these knives did not appear to have lower values of L_p.

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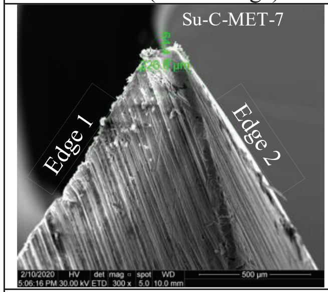
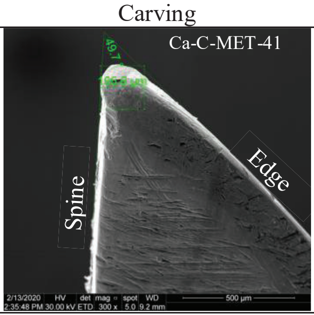
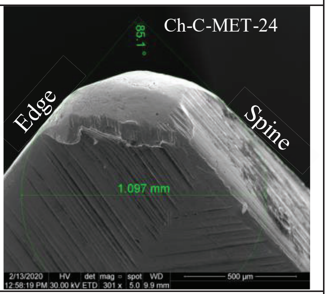
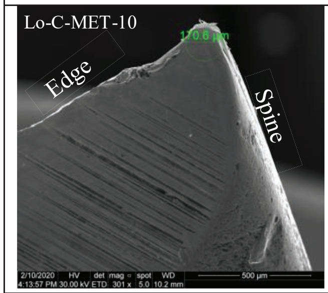
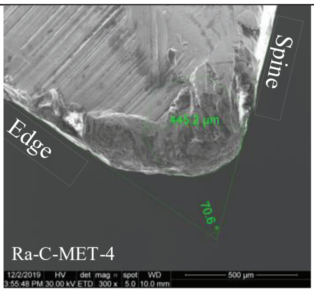
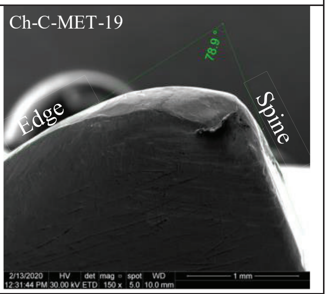
Survival (double edge)	Carving	Chef's
		
64° - 0.23 mm – 0.63 kgf	50° - 0.20 mm – 0.50 kgf	85° - 1 mm – 1.24 kgf
Lock	Rambo	Chef's
		
79° - 0.17 mm – 0.69 kgf	71° - 0.45 mm – 1.42 kgf	79° - >1 mm - DNP

Figure 8: SEM images of some typical knives. SEM measured Tip Angle, Tip Radius and the Penetration Load are shown below each. Note different scale bar for the DNP example

3.4 Correlation between Knife Geometry and Penetration Load

A common view is that the geometry of the knife tip defines its "sharpness" and thus can be used to predict its ability to penetrate materials in a stabbing action. Commons sense would suggest that a knife exhibiting a low penetration load would have a small Tip Angle and a low Tip Radius. However, the tip angle versus penetration force data in Figure 9 (top left) shows high levels of scatter for all the confiscated knives suggesting that Tip Angle alone is not a good predictor of the force required to penetrate.

For 23 of the confiscated classified as "sharp", the tip angles ranged from 37° to 75° and 46% of the these required higher loads to penetrate compared with the new knives with similar tip angles. For confiscated sharp knives L_p increased by 0.43 kgf for every 10° increase in tip angle with a moderately good correlation ($R^2 = 0.43$) as shown in Figure 9 (top left).

For the sub-set of confiscated knives with rounded tips (27/66) there was no meaningful correlation between L_p and the optically measured Tip Radius (R_T), with around 20% of knives lying significantly away from the main group (circled in Figure 9 bottom left). It was possible to identify a "main group" in the data where there was an increase in L_p of 0.28 kgf for every 0.1 mm increase in the radius with a moderately good correlation ($R^2 = 0.41$).

The 9 new knives with sharp tips had tip angles (TA) between 42° and 72° and showed a range of L_p from 0.32 kgf to 0.8 kgf which was noted as being lower than the results of Nolan [5] for similar tip angles. Every 10° increase in tip angle led to an increase in L_p of ~ 0.16 kgf with a moderately good correlation ($R^2 = 0.38$). Note that the gradient (rate of increase of penetration load with tip angle) is substantially different between sharp new and sharp confiscated knives, by a factor of 3.6.

The P1B has the lowest penetration force ($L_p = 0.18$ kgf), while the lowest value for any knife was Lp = 0.31 kgf (filleting knife, TA = 23.5°, $R_T = 0.33$). Only 6% of the confiscated knives had L_p values less than twice the L_p value of the P1B, where as for new knives this figure was 42%.

A number of additional methods were used to try and improve the correlation between L_p and knife tip geometry. For example, for a rigid spherical indenter (e.g. a rounded tip) indenting an elastic material, the maximum pressure is proportional to $(R_T)^{-2/3}$. For a cone (similar to a sharp knife), it is proportional to tan(180 - TA)/2). However, using these approaches did not yield correlations with lower scatter. Combining the tip parameters in a simple manner, e.g. x = (TA x t)/R_T and several variations of this, did not improve the correlation or reduce the scatter.

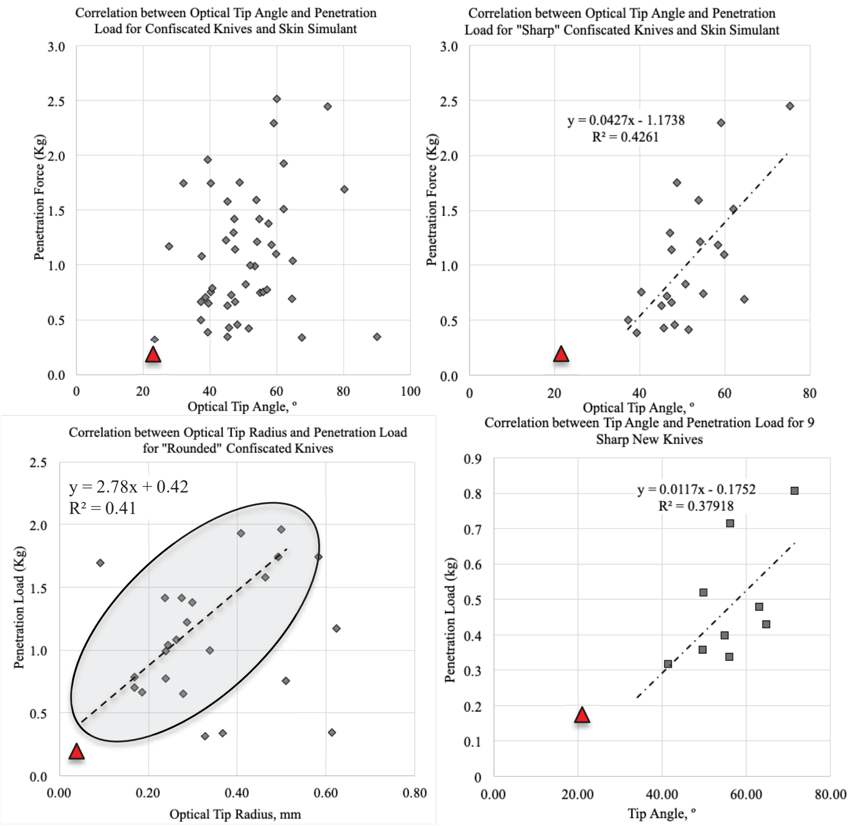


Figure 9: The correlation been between optically measured tip angle (TA) and penetration load (L_p) for all confiscated knives (top left) and only sharp confiscated knives (top right). Correlation between optically measured tip radius and L_p for rounded confiscated knives with "main group" circled (bottom left). Correlation between tip angle and L_p for 9 sharp new knives (bottom right). (triangle indicates result for P1B – TA = 23°, R_T<0.1 mm, L_p = 0.18 kgf)

4. DISCUSSON AND CONCLUSION

This work can be compared with previous published work using very similar skin simulants [5] [6]. In the prior research there has be no, or at best a very weak, correlation between knife tip geometry and penetration ability. As such the sharpness of knives in stabbing action is currently undefined.

This work shows that by categorizing the knives by their tip appearance as "sharp" or "rounded" and then optically measuring the tip angle (in side view) and the tip radius (if rounded) a moderately good correlation can be found between the force for penetration, L_p, (a proxy for sharpness) and the knife tip geometry. The correlation of tip angle with L_p is significantly different for new knives compared with used (confiscated) knives, suggesting a different mechanism is responsible for penetration for the two categories. For confiscated knives the values of L_p for "sharp" and "rounded" knives overlapped, with both having the majority of L_p values in the range 0.5 kgf to 2.0 kgf. This suggests that the observation of a knife tip being "sharp" or "rounded" is not in itself a useful indicator of penetration ability i.e. a low tip radius knife can be as sharp as a low tip angle knife and a high tip angle knife can be as blunt as a large tip radius knife. The actual value of tip angle and tip radius need to be measured carefully and in a consistent manner to determine the penetration ability. Combining the geometrical factors such as tip angle, tip radius and blade thickness in a number of ways so as to account for the 3-dimensional nature of the tip did not produce better correlations with the penetration load. Using classical contact mechanics to estimate the maximum stress imposed by different geometry knife tips did not yield good correlation with L_p.

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It is worth noting that the penetration forces measured for a significant number of knives, both new and confiscated, are significantly lower than those reported by previous research [4], suggesting the threat presented by such knives may have been being underestimated. However, no knife measured in this work approached the high sharpness (low penetration force) of the P1B.

If "sharpness" is now defined in terms of the penetration load (L_p), with low values of L_p being sharper, then it can be stated that of all the knives measured (new and confiscated) none were as sharp as the P1B. However, 4 confiscated knives (6%) and 4 new knives (33%) were within a factor of two of the P1B sharpness. For used knives 66% were more than 5 times less sharp than the P1B ($L_p > 0.9$ kgf). Confiscated kitchen knives were some of the sharpest and bluntest knives measured. Confiscated knives such as the Rambo type knife were not sharper than kitchen knives.

The scatter in the data is most likely a result of the 3-dimensional shape of the tip and the large number of possible variations thereof (Figure 8) which are very difficult to mathematically describe using simple measurements. Even accounting for a 3 parameter model (tip angle, tip radius and spine radius) is not sufficient to account for the complex nature of the tip on a scale of < 0.25 mm from the tip. Using SEM to image the tips provided a better insight into the features which give rise to the individual L_p values but measurements made from the SEM images did not in themselves improve the correlation between knife tip geometry and penetration load (sharpness). Capturing 3-dimensional data of the tip on a level comparable to the SEM images would be the most likely method to quantitatively define tip sharpness as it would make measurement of the true surface area of the tip possible.

This work has built on the previous understanding of knife tip sharpness and has shown how weak correlations exist between some aspects of easily measured knife tip geometry and the penetration force. It has also found, however, that the exact relationship between the knife tip geometry and penetration ability is a complex one and that further work is needed to understand it fully.

Statistical analysis of the data from 66 confiscated weapons and 12 new knives shows how the sharpness of these knives (as measured by L_p) varies significantly and ranges from 1.7 to 8 times lower sharpness than the P1B. For confiscated weapons the fact that 66% of confiscated weapons required more than 5 times more force compared to the P1B suggests there is potential for armour designers to use high performance materials to extend armour coverage to currently unprotected areas with materials which are less burdensome than the main body of the armour but still provide high levels of protection against the majority of street knives, alongside comfort and wearability. This may include, for example, under arm protection, forearm/wrist protection and neck and head protection.

5 References

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