GSDCA
GERMAN SHEPHERD DOG COUNCIL OF AUSTRALIA Inc

Hip Dysplasia and What Price a Normal Hip

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Introduction

The following article is an attempt to cover the many and varied aspects of hip dysplasia; its definition, the factors affecting the severity of the signs seen, the treatment of HD as well as the control of HD by (a) various schemes and (b) the genetic aspects. This somewhat rambling account is an attempt to show that the control of HD by concerned breeders is both difficult and complex. Additionally, the general public is being increasingly told that a “normal” hip is the only one acceptable, and anything above that may require surgical intervention.

As both a breeder and a veterinarian, we need to look at this problem from all angles and present to the general public a more realistic view of the condition, not only for ourselves, but for all breeds where clubs are trying to lower the severity of the HD problem. As the general public is becoming far more litigious in these matters it behoves us to present a rational approach with realistic goals.

Breeders' Aims

When we are breeding dogs, in addition to producing better show animals, we should also be trying to breed as sound an animal as possible. This encompasses all of the following:- physical, mental and genetic soundness as well as breed type (ie. it must still resemble the breed!). All of these areas are of great importance, some are weighted more heavily than others in different breeds. Over time various areas come under heavier pressure, eg. With all the current adverse publicity from dog attacks, heavier emphasis is being placed on temperament issues (as it should). Compromises often have to be made when balancing out the relative importance of different problems both within that animal and the breed as a whole.

The bigger the number of issues we attack at any one time, the slower the relative rate of improvement of the breed as a whole. With breed improvement schemes, the larger the number of genes involved in any one condition, again the slower the rate of improvement as well as the larger the environmental effects.

Genetic problems that result in a high incidence of blindness, crippling arthritis or vastly shortened life span (eg. the storage diseases), where there is pain and suffering on behalf of both the dog and the owner (be it monetary or emotional stress), the greater the effort that should be made to decrease the incidence of these problems.

The most important point is to keep the problems a breed has within perspective. This means that if there is a minor problem that does not affect the animal's soundness either as a working animal or its quality and length of life, that it should be kept in proportion relative to other problems within the breed.

The consequences of increasing weight and rapid growth.

Many of the joint diseases that occur in the dog arise often as the consequence of rapid growth in an increasingly heavy breed of dog (over time). Osteochondrosis (cartilage degeneration and damage) and joint dysplasias have been studied in many species, in particular in pigs.

In pigs, where the animals were selected for increasingly heavy end weight and rapidity of weight gain, the higher the incidence of symmetrical lesions in certain sites in joints and many growth plates. Experimentally the incidence and severity of osteochondrosis was directly related to rapid growth, ie. rate of weight gain. When the diet was restricted and the animals were grown at a low growth rate, the incidence of OCD was dramatically reduced (almost to zero).

All dog studies in this area have shown to support the concept that the high caloric intake rather than the specific intake of protein, minerals or vitamins influences the frequency and severity of osteochondrosis and HD. The causes of ED while not as thoroughly studied, show similarities and probably similar outcomes.

The common conclusion from studies in dog is that excessive calcium, phosphorus and vitamin D along with a high energy diet and rapid weight gain causing rapid growth, are almost a sure fire recipe for pushing the parameters for normal structural growth and joint soundness well beyond their normal limits, resulting in joint disorders. The higher incidence of osteochondrosis in males versus females is probably a direct reflection of this as males are often a ¼ heavier heavier in

Heavier (especially in the German Shepherd) than females at any one time, despite being born at a comparative weight.

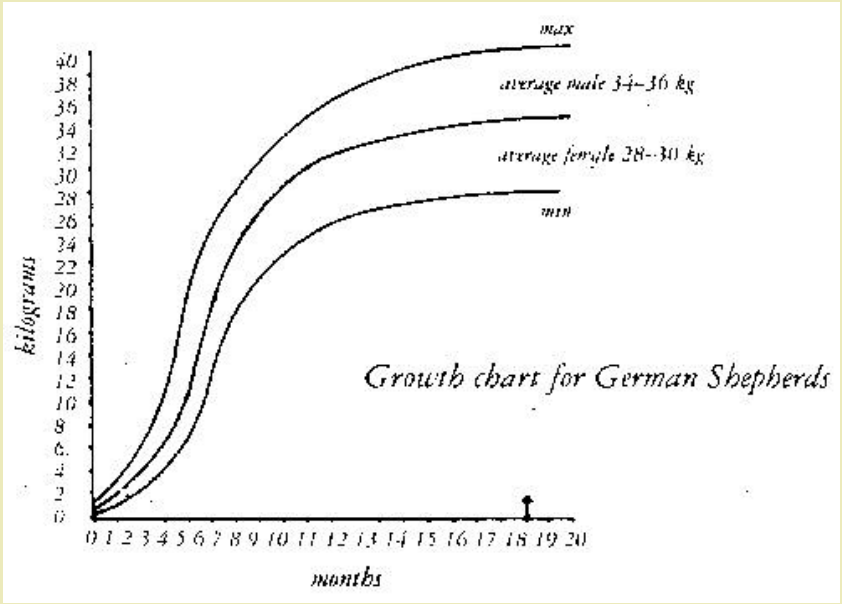
Equally this is not to say that genetics does not pay an important part in the body's structural soundness, however excessive rates of weight gain and thus rapid growth, result in pushing the body's parameters beyond which they can cope, particularly if they were not the most structurally stable to start with, ie. excessive rate of growth and weight will not create severe HD in itself; however, it can make an existing problem considerably worse.

Rate of Weight Gain - The causes of the development of hip dysplasia, as discussed below, are from a combination of genetic and environmental factors. Rapid weight gain and rate of growth through excessive nutritional intake can cause a disparity of development of supporting tissues. Factors affecting cartilage integrity (thickness and stability) and joint fluid composition, such as repeated trauma from excessive looseness of the joint and /or bacterial infections, can increase joint fluid production, thickening of the joint capsule, resulting in both joint pain and reduction in joint stability. These factors contribute to the development of joint looseness and subsequent subluxation, resulting in early clinical signs and joint changes. Control of the rate of weight gain, while it will not prevent hip dysplasia, it will allow a steady growth pattern allowing the hip structure to mature in concert with the strength of ligamentation in order to minimize excessive stress being placed on the hip joint.

Conversely to osteochondrosis, in breeds with a high incidence of HD, females generally have a higher average than males; due it is thought to the influence of female hormones. (a 4 point difference on average in the GSD).

Maximum to Minimum Mean Cumulative Weights

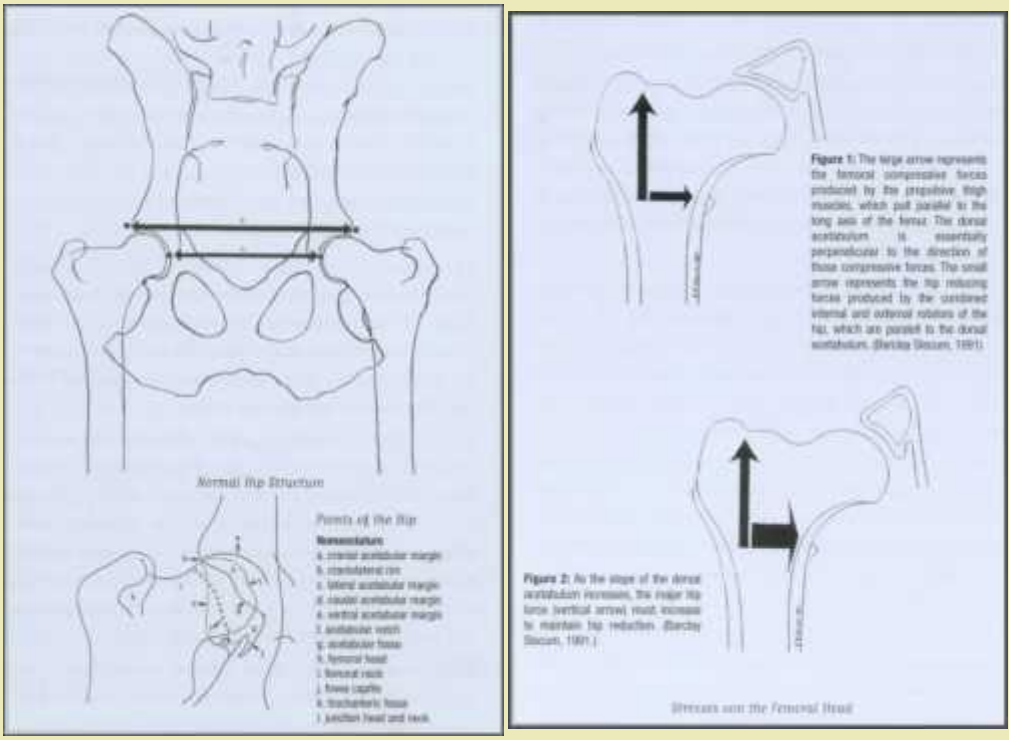
Weight (from 0 to 40 kilograms)



Age (from 0 to 20 months)

Growth Chart for German Shepherd Dogs

Average Proportional Weight (Kilograms) Gain Curve for Normal Growth over Time (Months)



Normal Hip Structure and Nomenclature ***Stresses on the Femoral Head***

Hip Dysplasia – its definition and structural components.

This is a disease that is very common throughout the dog breeds from Cocker Spaniels to Saint Bernards. It is most commonly seen in the heavier bone to muscle ratio breeds where the overall ligamentation is slightly loose. Hip dysplasia is by definition an ill fitting hip. The hip is a ball and socket joint, and the deeper the socket (ideally sufficiently deep to hold 2/3rds of the head of the femur), the better fit of the femoral head and angle of the neck and the tighter the ligaments, the better the hip.

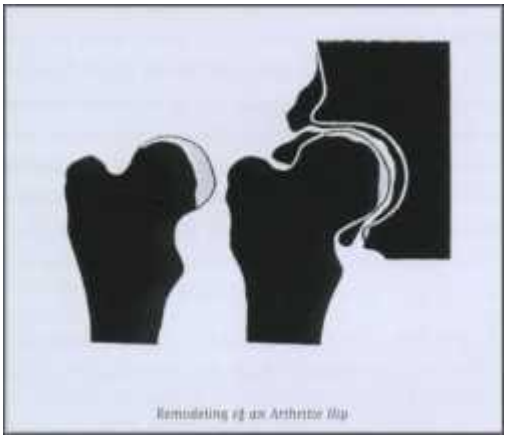
The various components that combine to give an unstable hip are combinations of the following :-

- shallow hip socket (the acetabulum),
- an ill fitting head of the femur (head too small, neck too short and steep),
- excessive looseness of ligamentation.

Where the socket is very shallow, the ligaments very loose and the femoral head either very steep in the neck or the head very small, these combination of factors lead to instability of the joint. Around the edges of the joint is attached the joint capsule, which in turn is attached to the periosteum. When the edges of the joint capsule are constantly being pulled, the periosteum is lifted and new bone is laid down in an attempt to stabilize the joint.

Pain from hip dysplasia is largely from wearing of the cartilagenous surface within the joint, exposing pain fibres in subchondral bone. There are two groups of animals affected :-

- Young group - 4.5 -10 months (rapid growth phase) and
- Older patients - with chronic degenerative disease



Remodelling of an Arthritic Hip

Examination for HD

Symptoms - Dogs with HD have a history of intermittent hindquarter lameness, pain on rising, poor hindquarter muscle development, narrow hindquarter action, reduced arc of movement, reduced exercise tolerance. Examination under anaesethic may show looseness while X rays will (if correctly positioned) give more definitive view of anatomical details as well as arthritic changes and the degree of joint looseness.

In should be remembered younger, overweight dogs will be looser in ligamentation than older, fitter individuals. Different anaesethic agents and depths of anaesthesia can vary slightly the looseness of ligamentation seen. Positioning for X rays for HD assessment – it is most important that of the pelvis should be level, both from front to rear, and side to side. Too steep an angle of the pelvis front to rear will give the appearance of a shallower joint. Twisted, crooked pelvis side to side will have adverse effects on the hip tilted further away from the X ray plate.

Heavier, larger and looser ligamented breeds (and individuals) will exhibit the greatest arthritic changes. Some breeds tolerate looseness better than others.

 # Clinical signs often do not correlate with radiographic changes. Some dogs with moderate or even severe HD are asymptomatic.

Differential Diagnosis - In both groups of affected dogs but particularly in the younger group, the back should be assessed, especially when accompanied by generalized soreness from excessively rapid growth. Soreness along the back, usually obvious by arching along the middle (lumbar section), will affect the dog in both rising and extension during movement and manipulation.
Rule outs: - In the younger dog, lameness from other rapid growth associated conditions eg. Panosteitis, OCD, HOD or other injury to joints in the hindquarters. In the older dog, conditions such as cauda equina (neurological), acute or chronic knee injuries, bone neoplasia need to be taken into account.

HD rarely if ever presents ***as a sudden acute injury or onset.***

Methods of Treatment of HD

Treatment depends on the age of the patient and the severity of the symptoms, physical and radiographic findings and economics of the owner. Conservative and surgical options should both be looked at. Many younger dogs (60%) spontaneously improve with increasing age after conservative management and return to acceptable clinical function (Barr, Denny, Gibbs 1987). The remainder requires further medical or surgical treatment at some time in their life.

Surgical intervention is indicated where conservative treatment is not effective, where athletic performance is desired, or in young patients where owners wish to slow the progression of degenerative joint disease and enhance the probability of good long term limb function.(Small Animal Surgery 1997).

Medical Management

1. The younger patient – rest, correction of diet and weight if needed, use of drugs such as cartrophen to improve circulation to, and repair of cartilage, use of other anti-inflammatory drugs. Rest and recuperation for as short as 2-3 weeks can make remarkable improvements.

2. The older patient – again weight should be considered as too heavy in condition will acerbate wear all the joints, not just the hips. Again use of the same drugs as above can give remarkable results. Rest with severe cases is always advised.

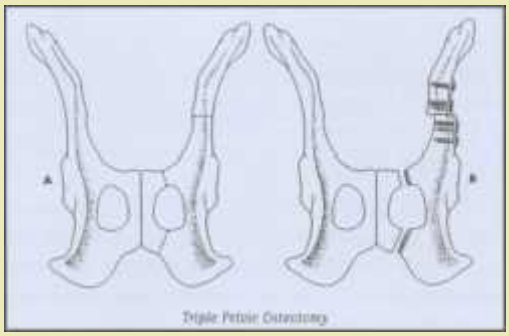
Non steroidal drugs include Aspirin, PBZ (phenylbutazone), Rimadyl*, Metacam*, Cu Algesic*.
If dogs in either group fail to respond to appropriate treatment, dietary changes and rest, then surgical intervention may be necessary.

Surgical Intervention

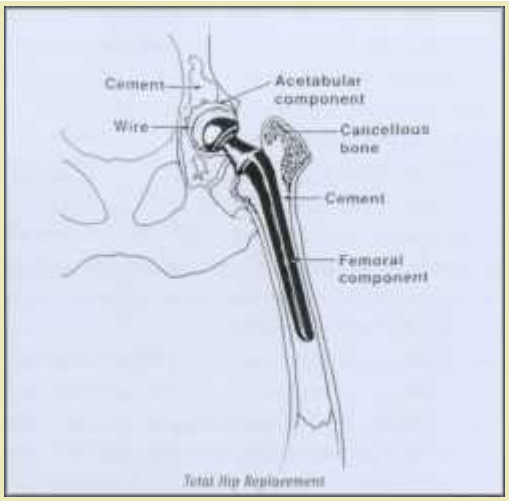
1.Pectinomyotomy – this is the mildest (also cheapest and quickest) way to get some relief in the HD patient. This was used quite frequently in the past where there were fewer options available. This muscle cutting operation transects the pectinius muscle, a muscle that runs high on the inside of the thigh and pulls the leg medially. Cutting this muscle relieves tension on the joint capsule and eases movement by reducing medial pull of the limb. This can be very useful in the younger patient (6-12 months), particularly where funds do not permit the more radical operations. Can get good pain reduction, and does not interfere with any other surgical option at a later date.

2. **JPS** (**juvenile pelvic symphysioddesis**) – this is an operation where the pelvic symphisis is fused at 12-20 weeks of age. The result of this is that the hip sockets tend to rotate into a better position for long term hip stability. The best results are for dogs with between .4 and .7 degree of laxity (PENN hip). This operation is not overly invasive and the results can be very good. Affected dogs are usually desexed at the same time. For this operation to be most effective it should be done earlier than later, the effectiveness over 16 weeks of age is still under debate.

3. Triple Pelvic Osteotomy – this is ideally done in dogs before they reach 9 months of age, where the pelvis has not yet finished growing. This is done to axially rotate and lateralize the acetabulum in order to increase the dorsal coverage to the femoral head. This operation is not suitable where there is insufficient depth of acetabulum to hold the femoral head. The results are best where there is minimal degenerative change. **Costs** - Generally both hips are done at once, cost is around $6000.



Triple Pelvic Osteotomy



Total Hip Replacement

4. Total Hip Replacement – is the replacement of a degenerative hip joint with a prosethetic acetabular cup and a femoral head/neck component. This is used on the older patient where conservative treatment is not effective. The success rate is good to excellent with an orthopaedic specialist. This is usually not done much on breeds or individuals that weight less than 20 kg (very hard to get small enough prosthetics at this time). **Costs** - Cost per hip is $3000 and up.

5. Femoral Head and Neck Excision – limits bony contact between the acetabulum and the femur and a fibrous joint is formed. This is a type of operation routinely used with dislocations of the hip from trauma, in the case of HD dogs it is used where conservative treatment has failed and there are financial constraints against a total hip replacement. The results are no where near as good as with (3), as there are fibrous changes and restrictions of movement, but this is largely seen as a salvage procedure. However, many dogs do very well and have improved function. (# Once this operation has been done, other surgical options are virtually nil.)

Discussion

Given the very high percent of younger dogs that respond to rest, conservative treatment and weight/dietary management (60%), ideally the first route of treatment should be conservative, medical management. Many breeds are quite loose in their ligamentation when young and if weight factors are above breed norms for that age and sex, then conservative treatment with calorie limitation should be tried.

Unless there are substantial abnormalities present, ie. very shallow sockets, excessive luxation of the joint with arthritic changes developing and significant pain that is unresponsive, conservative treatment should be tried. If there are significant changes that are unresponsive to rest and treatment within the short term, then surgical options should be considered.

Older dogs should be tried on conservative management first, and again if not responsive, surgical options considered. The best responses are from total hip replacement, but the cost is high. If this cannot be afforded, the age of the dog should be considered, the older the dog, the more one leans to medical management, the younger the dog with severe symptoms, the more a surgical option should be considered.

Genetic and Breed Control Aspects of HD

Genetic Aspects

Definition - Inherited - this is the genetic material that is passed on to the next generation(s) unchanged by - although the "expression of" may be altered by - the environment. Inherited generally refers to trait(s) exhibited by the individual that breeders are interested in. Occasionally it may be a breed fault that they do not want exhibited eg. incorrect coat colour or texture; but mostly breeders are interested in maintaining particular virtues, and at the same time, removing the undesirable faults.

Where a condition is affected by more than 3 genes, these are called polygenetic and are much harder to clear from the population as the effects are often a blend of the effects of the genes and the environment acting together. The more genes that are involved, the greater is the chance that the environmental factors will affect the end result. Environmental factors include diet, rate of weight gain, level of activity, stress factors etc.

Breed Aspects in relation to Control Schemes

Hip Dysplasia is a polygenetic condition, ie. many genes affect the outcome. The more genes affecting a characteristic, the harder and slower it is to eradicate or affect the characteristic, and the more environmental effects come into play (diet, weight, rate of growth etc). Where there are ways to measure the condition, then progress can be made in controlling the effect of the condition in the overall population eg. Hip Dysplasia - X raying of individuals and their progeny.

The schemes currently in use for control/reduction in severity of HD and ED aim to reduce the incidence and overall severity of these conditions across the breed (a) as a whole and (b) over time. Trying to shift the genetic structure of polygenetic conditions within a breed is a long term goal, and cannot be pushed rapidly without severe consequences in other areas (eg. type, temperament etc).

The overall picture must be considered. Trying to eliminate all dogs with hip dysplasia did not work (attempted in both GSD's and Labradors), the end result was a greatly reduced genetic pool, cases of HD still occurring and breeds that did not resemble the standard. The main aim today of most hip schemes is a gradual reduction in the breed average while at the same time allowing breeders to preserve valuable bloodlines and decreasing the incidence of really severe HD. The hereditability of HD varies in different breeds, the higher the degree of inheritance, the more rapidly changes can occur within a breed when selecting for that characteristic. Also, a dog that has a good hip score, may not necessarily throw low scores in his progeny, a full litter brother with a similar score may have a far lower progeny average than his brother.

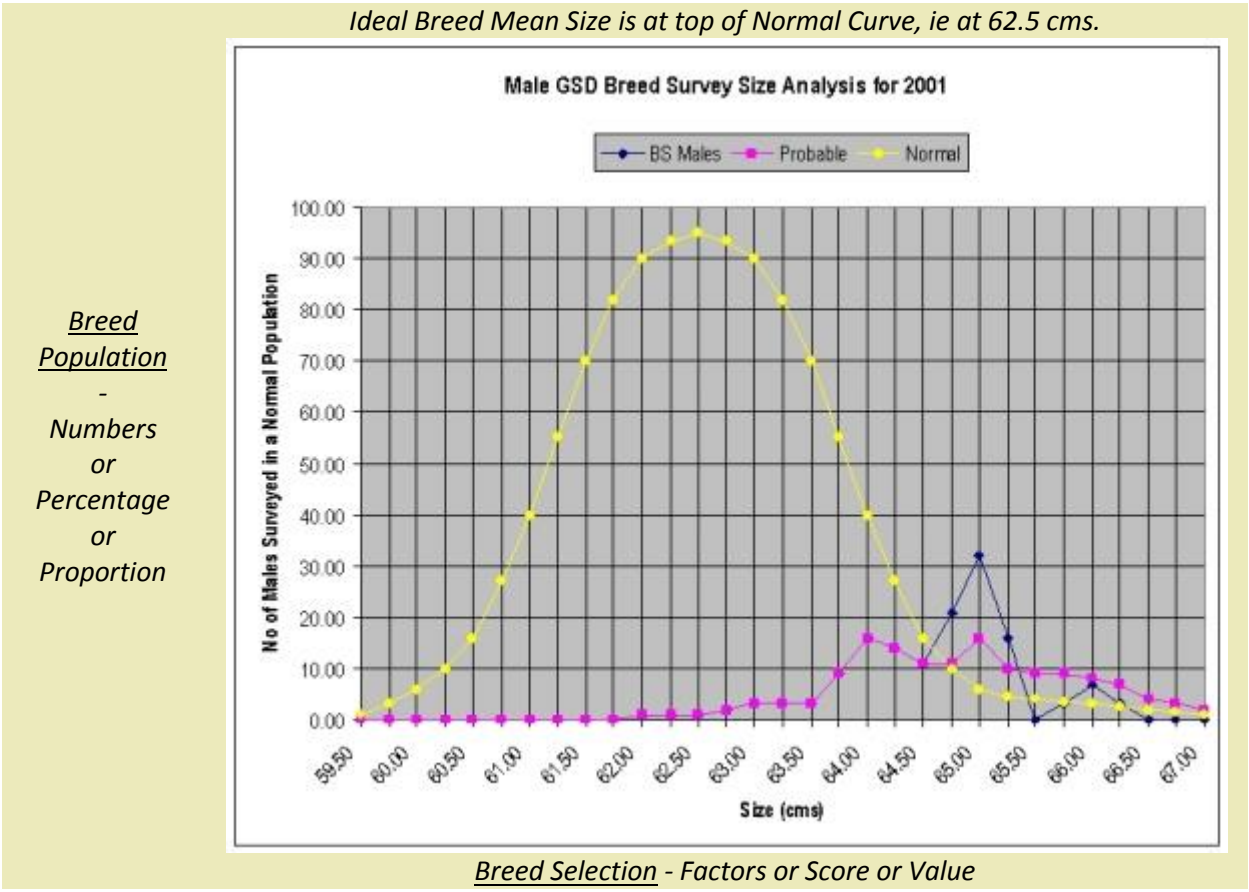
Until there are very reliable breed specific DNA markers or gene tests, rapid change within breeds, and therefore breed averages, will not be possible.

Population Means and Spread (of any measurable factor)

Populations can be described by a bell curve which can apply to any feature you wish to look at, be it height through a breed, litter size, HD scores and so on. With this curve, the top of the curve is the mean of the population factor being assessed (eg. height) with the extremes at either end of the scale (eg. the shortest and tallest).

Diagram of a Bell (Normal) Curve

Ideal Breed Mean Size is at top of Normal Curve, ie at 62.5 cms.



Breed Population - Numbers or Percentage or Proportion

Breed Selection - Factors or Score or Value

Proportional Frequency Polygon for Normal Distribution (Normal Curve)

If in German Shepherds we apply this to height, and we have height limits on the breed; while we wish to breed strong, well boned dogs (who generally are on the large end of the scale), we have to fit (or attempt to fit) the vast majority of dogs under the limit, so the breeders will usually discard the tallest and the smallest, and generally work with the medium to large range of the population.

This same principle can be applied to any genetic problem within a breed. If the incidence of a problem is small across the whole breed, eg. 5-10%, it can be fairly easy for breeders or clubs to say not to breed with affected animals. If, however, the problem has a variable expression and/or a complex means (polygenetic) of inheritance, this can affect virtually every member of a breed eg. Hip Dysplasia, to some degree.

HD X-Ray Control Schemes

1. Grading – where various aspects of hip construction, looseness of joints is looked at and assessed. The current international grading system has 0-6 grades, also called A-F (in some countries). The worst grade per hip gives the overall grade (ie. if grade 0 in 1 hip and 3 in the other, the overall grade is 3).

2. Scoring – using the BVA System where 9 different areas of the hips are measured and scored (generally out of a 0-6 scale). Total score per hip given as well as overall total (maximum 106). Very useful in determining the breed average. If combined with a grading system, again the hip with the highest score will determine the overall grade (the ED scheme works on a similar score/overall grade basis).

The Australian 'A' Stamp is given by the GSDCA for hips that have a total score of 8 or less per hip, and are considered within normal limits of the breed and suitable for breeding purposes.

3. PENN Hip – dogs are anaesthetized and subjected to standard pressure, and then X rayed, to determine the degree of joint laxity. Many breeds exhibit varying degrees of joint laxity both across the breed and within the breed. The relevance of the joint laxity when done at an early age (4-6 months) needs to be seen relative to long term hip results (ie. against standardized HD X-rays at 12-18 months of age. Some breeds are more "laxity tolerant", ie. the rate of change predicted is not as high in some breeds as others.

Breed Averages and Medians

Breed Average - means all the scores from all the submitted animals being totalled and the divided to find the average for any member of a breed being checked for that characteristic (HD) will have a result (score or grade) close to that average score.

Breed Median - a breed median is the result for that breed where 50% of the breed will be better than that figure and 50% will be worse. In breeds where there are smaller populations being scored, the breed average may be considerably higher than the breed median. With increasing numbers (thousands) these figures are considerably closer.

With HD Schemes, we are working with empirical tests with large degrees of variability within them, it is therefore essential that every breed be looked at from as broad a spectrum as possible so that a relevant decisions can be made as to the breed worth of that individual. As we discussed above, when looking at a population, the spread of the population as well as the population mean is essential if making decisions as to what one can afford to discard from that population. Combined with this we need to estimate how many other individuals that are being culled for various other reasons so that in looking at a breed population as a whole, we need to retain at least 75% of the population for any one characteristic being selected for.

When breeding, we obviously wish to breed from the best, soundest dogs, but as started before, this should be kept in perspective in relation to other genetic and breed soundness characteristics that are necessary. For that reason, we generally breed up to and often slightly past a breed average if we wish to retain sufficient breeding stock for the overall health and viability of the breed.

When discussing HD in the GSD, the breed average (BVA total score) is currently around 7.5 in Australia after some 20,000 dogs being scored/graded (the UK average is 18.73). When allowing for differences per hip as well, the average score per hip is around 7 to 8 (a maximum of Grade 3 if grading), a maximum of 8 per hip is allowed by our national governing body, the GSDCA if an A stamp is issued, indicating that the overall quality of the hips are suitable for breeding. As the total score per hip can go to a maximum of 53, a cut off of 8 per hip is quite low.

In the GSD as the heritability of HD is quite high, reasonably rapid improvements can be made, and generally more than 75% of the dogs submitted will pass these stringent requirements, indicating that the spread of the population is reasonably narrow.

In other breeds the breed average may be much higher, the inheritance lower and the population spread much greater if one looks at the 75% of the population one wishes to keep, eg. the Golden Retriever, current breed average around 11, this mean has shifted well (down from 22 some 30 years ago) due to hard work by breeders as well as breed improvement schemes LRL's for hips, elbows and eyes. In this breed one would have to go to at least a score of 10 per hip if not slightly higher in order to retain sufficient breeding stock across the board.

If the breed average is above 20, efforts should be made to select and breed from stock under 20, as scores over 20 will generally result in significant arthritic changes over time (ie. as the dog ages). Where superior individuals have scores significantly higher, great care should be used if breeding from these animals, ideally using partners will very low scores and preferably where these partners have themselves already produced low scoring stock.

Correct Use of the Inherited Diseases Schemes by Breeders

The whole idea of these schemes is to give breeders information so as to give them knowledge prior to breeding an animal as to what one could afford to do.

BVA Scoring Scheme - Obviously an animal with a higher score should be used with more care and preferably to a sire or bitch of low score/grade and preferably where there are known family or sire averages. This type of system works where sire statistics are published, where the average score of the sire (where more than 20 progeny are scored) is of greater accuracy in predicting the average score of his progeny, than the score of the sire himself.

In the **German Breed Value Scheme** – Breed values are assigned along similar lines, where their data base encompasses litter mates, sire averages etc to give a more complete breed value per individual and outcomes for any expected mating. The breed values for an individual are out of 100, and the SV have gone 1 step further by saying that the combined breed value of the parent should be less than 200. This appears to be working quite well.

The conclusion one gets from these schemes, is that ***the more information*** one has both of the parents themselves and of the close relative, particularly offspring of the sire, the better one can plan and get successful results across a litter. In breeds where such information is limited and/or sire statistics are not available, breeders have much harder time selecting good sires and good breeding combinations.

<u>Expectations of a Normal Hip</u>

What is Normal – Normal Grade or Normal/Average for that Breed.

Normal hips are technically a 0/0, going up to around a maximum of 2-3 per hips.
Normal hips for a specific breed - ie. average hip status, can be vary greatly between breeds.

Discussion

Technically by defining a normal hip score or grade, makes any higher score or grade dysplastic. However, an 8/8 hip for GSD is within the normal range of the Australian breed average, just as a 10/10 score can be “normal/average” for a Golden Retriever. We are often being penalized for breeding puppies that score or grade above the normal grade, rarely is the breed average for that breed considered. Legally we need to have a better definition of either what are normal hips, or better define what is considered as soundness for breeding purposes within that breed.

Age factors - On looseness of ligamentation, just because a dog is loose at 6 months, but otherwise has good joint anatomy (deep sockets, good femoral heads and necks), it does not necessarily mean that the dog will be grossly dysplastic by either 12 months or even by middle age. If a dog hips are within a normal range or even slightly above average for that breed, and there are no signs of lameness, should one interfere just because we can? Because of that looseness, younger and younger dogs (puppies) are routinely being considered for surgery.

Older dogs are similarly being targeted for hip operations even where changes are minimal. Often these dogs on further examination have either back (spondylitis) or other conditions present and have been often “diagnosed” by breed alone.

Conclusion

In conclusion, with increasing owner reliance on litigation, we as breeders (and the Kennel Controls) need to develop a broader definition of normal in regard to breeding stock. Is it within the normal breed average, that breeding stock should be selected at or preferably below the breed average. Ideally sire statistics should be looked at more carefully as well as sibling results. Broader expectations should be given to the public explaining while we as breeders can try as hard as possible to breed “normal” hips (and elbows), we can occasionally turn up bad results due to the polygenetic basis of the conditions we are looking at.

Similarly it would be most prudent that breed clubs develop normal weight ranges for the differing sexes at various ages, that can be handed out, so that novices (owners, breeders and veterinarians alike) can be what is normal rate of weight gain for that breed, sex and age. Large variations in weight above normal are likely to exaggerate any inherited abnormalities of structure, particularly looseness of ligamentation.

Further References

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