Big or Small Focus – What is Behind?

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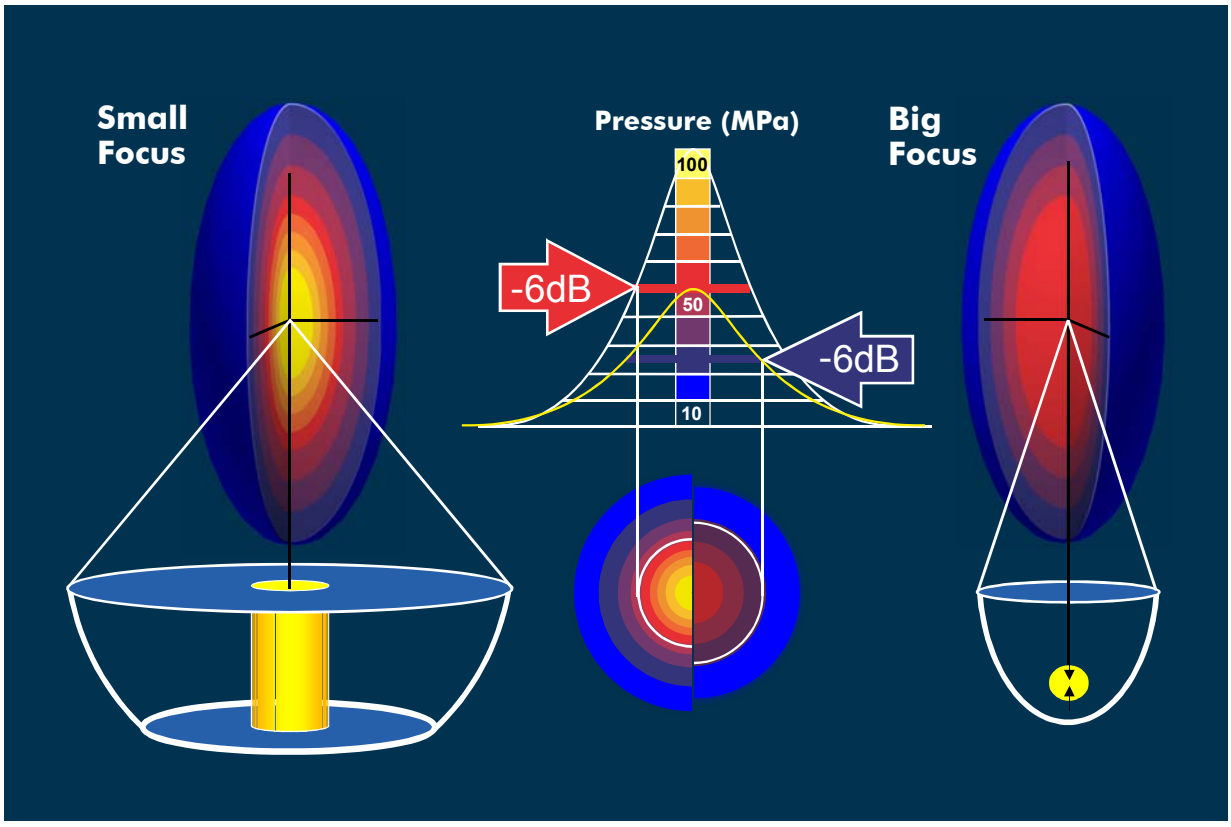
Whenever a strong shock wave effect is required, a big focus is more favourable than a small one? The statement seems to be simple and clear. However, as usual in ESWT, reality is not as simple.

As long as shock waves are considered the reason for healing effects in tissue, the acoustic energy disposed in the tissue region of interest, is of decisive importance. The focal size, however, is no measure for the amount of energy applied. In other words: The treatment zone, which means the zone where we can expect a shock wave effect, is not defined by the focal (–6dB) zone. The treatment zone may be significantly larger or smaller than the focal (–6dB) zone depending on the energy level selected. The discrepancy of the two zones is due the fact, that the treatment zone is assumed being related to the absolute amount of energy deposited in the tissue whereas the definition of the focal zone does not care about the amount of energy at all.

Generation, transmission and focussing of acoustic energy

Whatever shock wave device is used, different energy levels can be selected according to the individual needs of the patient's indication. Usually, maximum levels are seldom used due to limited pain tolerance and possible side effects. Shock wave transmission from the generator to the affected tissue is done via an extended skin area with low energy concentration in order to limit skin lesions. Wide aperture generators feature less skin lesions than small aperture systems.

The quality of focussing simply determines how well the pre-selected amount of energy is concentrated to a more or less well defined area. It is by no means difficult, to generate a big focus. It is tricky, however, to focus the shock waves to a small area. From an efficacy and safety point of view it is always beneficial to generate a small and well defined focus to affect exactly the target area and care for the surrounding tissue.



Due to physics a small focus is only possible with large apertures and generators with small apertures are only capable to form a big focus. It must be emphasized again that this holds true independent from the energy content and thus from the expected medical efficiency.

According to the definition, the –6dB focus is a relative measure relating to the maximum pressure. Depending on the actual energy level this might be 50, 100 or 1000 bar (5, 10 or 100 MPa) or any selected value which can be delivered by the individual device. Fig. 1 shows an example of a wide aperture system with a small focus (left) and for comparison a system with a smaller aperture and a big focus accordingly (right).

The left system is shown with a peak pressure of 100 MPa whereas the right systems features a smaller peak pressure of 50 MPa. At any position in the focus area the left system provides higher pressure values than the right system as shown by the pressure curves. The left system clearly contains more energy than the right system.

The pressure field declines steadily with lateral distance from the centre. The focal area behaves more like a candle flame dissipating heat in the surrounding space without having precise limits than a cigar shaped solid body Physicists prefer to calculate with exact numbers and, therefore, define a precise line at exactly that position where the pressure has declined to half of the actual peak pressure measured in the middle of the field. This limit is called the "-6dB-line".

As shown by the example of Fig. 1, the –6dB diameter of the pressure field – this is defined as the focal (-6dB) zone – may be even larger for the right system with less energy than for the left system with clearly higher energy. We conclude: The dimensions of the focal (-6dB) zone is by no means a measure for the power and the medical efficacy of a shock wave device.

In order to get a feeling of the power of a system absolute pressure values have to be considered. There is a consensus developed by several manufactures of shock wave devices that among others the 5MPa limit of a shock wave field may define the dimension of the treatment zone in a more appropriate way. Even if the 5MPa focal zone may not exactly display the efficacy limits of a shock wave device, it changes according to the selected energy levels and thus reflects the variation of the effected tissue more realistically.

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