CHAPTER 5: DISCUSSION

5.1. The effect of splint on masticatory muscles activities

In this study, soft splint significantly reduced the maximum clenching activity of anterior temporal and masseter muscles of TMD patients but not the postural activity. Meanwhile, soft splint caused no significant difference in the muscles activities of healthy subjects. Discussion was done in following section to compare with others studies.

Soft splints were less documented in the scientific literature. There were even less EMG tests that had been carried out on soft splint. Most published studies focused on hard splints. Therefore part of the discussion in this study had to rely also on published papers on hard splints.

5.1.1. EMG variability

Despite of careful and meticulous preparation, EMG recording seemed to show variability even within the same subject. Therefore in this study, paired EMG readings were recorded without changing the position of the electrodes and cable. Samples were only paired if there were collected from the same subjects in the same visit with same setting. Analysis was performed to see if there was any significant difference in paired samples. In looking for difference, subtraction was done within every paired sample. Thus, variability or small artefact that was common to paired samples would off set each other.

On the other hand, due to the variability of EMG test, normal physiological values for postural and maximum clenching muscle activities were therefore difficult to be constructed. Thus, this study showed no attempt in comparing directly the absolute EMG reading between individuals. Interpretation of EMG data should also be done conservatively but not over enthusiastically as in this study.

5.1.2. The effect of the soft splint on the masseter and anterior temporal muscles activities

There were relatively less studies carried out to study the effect of soft splint on EMG activity of masticatory muscle. Two EMG studies that involve soft splint were actually intended to compare the effect of the hard splint with the soft splint which were the study by Okeson (1987) and another by Al-Quran and Lyons (1999).

5.1.2.1. The study by Okeson (1987) versus this study

Okeson (1987), in his study (n=10) of the effect of hard and soft splints on nocturnal bruxism in healthy subjects, reported that the hard splint significantly reduced nocturnal masseter muscle activity while the soft splint significantly increased the masseter muscle activity. Okeson’s study did not report data for anterior temporal muscle. In this study, before conservative treatment, in experimental group, there was no significant difference in the postural EMG activity before and after insertion of the soft splint for both the masseter and anterior temporal muscles. However, the clenching EMG activity was significantly reduced after insertion of soft splint for both these muscle.

These diverse results may simply due to the nocturnal muscle activity in Okeson’s study was not the same as the postural and maximum clenching activity in this study. The nocturnal muscle activity measured in Okeson's study was the dynamic muscle activity that included any clenching and grinding muscle activity through out the sleeping time at night. The muscle activity that was examined in this study were at postural level and maximum clenching level which were the static muscle activity without dynamic movement of mandible. Moreover, the nocturnal muscle activity was produced subconsciously during sleeping while maximum clenching activity was produced consciously and intentionally during awake. In other words, the study on nocturnal muscle activity could not be exploited to answer the whole effect of soft splint. Besides, in Okeson's study, the nocturnal muscle activity was recorded for 5 consecutive nights for control period or 7 consecutive nights for treatment period. The total muscle activity recorded would then be averaged out to obtain the mean activity per hour. Therefore, the EMG measurement run on each subjects actually involved replacement of electrode at new location every night. It was known that repositioning of electrodes had contributed to the variation in EMG recording (Frame et al., 1973; Nouri et al., 1976; Soderberg, 1992). In this study, the muscle activity on each subject was recorded before and after the insertion of splint in same sitting without repositioning of electrode. Therefore, any effect due to electrode repositioning was obliterated.

On the other hand, the response of TMD patients towards the splint may be different from that of healthy subjects as pointed out also by Wright et al. (1995). Therefore, the healthy subjects in Okeson's study may not be comparable to the TMD patients in this study but relatively may be more comparable to the healthy control subjects in this study. However in this study, the healthy control subjects showed no significant difference in EMG activity after insertion of splint. This may again due to the reasons as mentioned above.

5.1.2.2. The study by Al-Quran and Lyons (1999) versus this study

Al-Quran and Lyons (1999), in their study (n=10) of the effect of hard and soft splints on the EMG activity in healthy subjects, reported that the maximum clenching activity of the masseter muscle was non-significantly decreased with hard splint but significantly increased with soft splint. According to them, the increase in activity of the masseter muscles when clenching maximally on a soft splint could simply because the soft material was more comfortable to bite on compare to hard splint. They also reported that both the hard and soft splint caused a non-significant decrease in the maximum clenching activity of anterior temporal muscle.

This result was in contrary to that of this study. As mentioned earlier, the TMD patients may respond differently towards the splint compare to healthy subjects. Thus, relatively the healthy subjects in their study were more comparable to the healthy control subjects (n=10) in this study. However in this study, there was no significant difference in the EMG activity before and after insertion of splint among the healthy control subjects. The difference in results may be due to the sample size was small which was ten. As reported by Al-Quran and Lyons, the relatively wide variation in the effect of the splint was noted between subjects. This may be due to differences in the vertical dimension of the splints, number of teeth in occlusal contact and variation in the degree of comfort of the splints. The different result seen between their study and this study awaits differentiation by future study with larger sample size.

5.1.3. The effect of the splint on TMD patients compared to healthy subjects

In this study, soft splint significantly reduced the maximum clenching activity of anterior temporal and masseter muscles of the TMD patients but not the healthy subjects. This result suggested that the soft splint would produce different effect on TMD patients compared to healthy subjects.

As in the literature review of this study (section 2.9.2.2.1.), the hard splint generally results in a significant decrease in both of the postural and maximum clenching activity of the masseter and anterior temporal muscles of the TMD patients. In contrary, as in the literature review of this study also (section 2.9.2.2.2.), the hard splint generally causes no difference in the maximum clenching activity of the masseter and anterior temporal muscles in healthy subjects. Thus, the hard splint generally would cause different effect on the TMD patients compared to healthy subjects. This finding was in line with this study.

As in the literature review of this study also (section 2.9.3.2.), TMD patients generally have higher postural activity but lower maximum clenching activity in the anterior temporal and masseter muscles compared to healthy subjects. The lower maximum clenching activity in the anterior temporal and masseter muscles of the TMD patients compared to healthy subjects suggested that the TMD patients had weaker elevator muscle. It was suggested that the weaker elevator muscle was more sensitive to the stretching of the muscle caused by the splint upon insertion. The stretching of the muscle might stimulate the muscle spindle and the Golgi tendon organ which in turn caused the muscle relaxation. Therefore the maximum clenching activity of the muscle would be significantly reduced by the splint. For healthy subject, the elevator muscle was suggested to be stronger and therefore less effected by the splint upon insertion.

Therefore, it was suggested also that the EMG study done on healthy subjects could not be regarded as identical to EMG study done on TMD patient. Any result reported from the study done on healthy subjects should not be used boldly to make inference on TMD patients.

5.1.4. The effect of the soft splint in this study compared to hard splint

In this study, soft splint significantly reduced the maximum clenching activity of anterior temporal and masseter muscles of TMD patients but not the postural activity.

As in the literature review of this study also (section 2.9.2.2.1.), the hard splint generally caused a decrease of both the postural and maximum clenching activity in both the masseter and anterior temporal muscles of the TMD patients.

This finding suggested that soft splint could produce similar result in reducing the maximum clenching muscle activity of TMD patients as compared to hard splint. Both the splints might serve similar mechanism of action which were due to the sensory changes in masticatory system or the increase of the vertical dimension cause by the splint. The sensory changes were mediated by the peripheral receptors that were in the TMJ (due to altered condylar position), from the muscles (due to longer working length), from the periodontal ligaments (due to altered tooth contacts), and from the tongue, lips and the oral mucosa due to the presence of a foreign object (i.e. the splint) (Al-Quran and Lyons,1999). Manns et al. (1983, 1985) had reported that elongation of elevator muscle by means of occlusal splint produced neuromuscular relaxation.

However, it was found that soft splint produced different effect on the postural muscle activity of TMD patients as compared to hard splint. This might most probably due to the soft nature of the soft splint. When a splint is being inserted into the mouth, it actually invades the freeway space. In postural position, splint might cause slight tooth contact on it. The hard nature of the hard splint probably caused the slight tooth contact on the splint to produce more sensory information to CNS as compared to the soft splint. Since the absolute EMG value of the postural muscle activity was in a few microvolts, less sensory information produced by the slight tooth contact on soft splint would cause no significant difference in the postural activity after insertion of splint. The difference in sensory information produced by these two types of splint would actually cause the different effects of the splints on the postural activity. This was supported by the study of Visser et al. (1992), which reported that at lower clenching levels, sensory information from the masticatory system had a more important influence on the muscle activation patterns, which might be true also at postural levels.

On the other hand, the reason that the soft splint caused no significant difference in postural EMG activity could be due to the mixed responses of the patients towards the splint. It was suggested that some individuals responded by further relaxing the muscle to avoid tooth contact onto the splint. Some individuals however started to bite further onto the splint. The reason behind in producing these two different responses was unknown and might lie in the higher central nervous system.

5.1.5. Reduction of parafunctional activity by the splint

In this study, maximum clenching EMG activity was significantly reduced after insertion of the splint in TMD patients but not in normal subjects. It is suggested that the splint may help to reduced parafunctional activity especially in TMD patients with clenching habits. However this was not demonstrated directly in this study. It was difficult to measure the parafunctional activity directly to compare the effect of the splint upon insertion. Sheikholeslam et al., (1986) reported that occlusal splint can offer an optimum occlusal condition that reorganizes the neuromuscular reflex activity, which in turn reduces abnormal muscle activity. Thus, it can decrease parafunctional activity that often accompanies periods of stress. Although soft splint do not offer an optimum occlusal condition, it might still reorganizes the neuromuscular reflex activity, which in turn reduces parafunctional activity.

The direct measurement of the parafunctional activity such as nocturnal activity would normally affected greatly by the procedure of methodology. Solberg et al. (1975) found that nocturnal masseter muscle activity was reduced immediately after the insertion of stabilization splint. However, the decrease in nocturnal muscle activity might not be due to the splint per se but might also due to the disturb cause to the subjects when the splint was inserted. This phenomenon was commonly observed that for an example, a person who was grinding the teeth during sleeping would normally stop grinding immediately when somebody tried to push his body even a small turn.

In the study by Okeson (1987), the nocturnal masseter EMG activity was increased in subjects with soft splint but significantly reduced in subjects with hard stabilization splint. However it was known that the grinding activity usually occurs on and off through out the sleep and it was inconsistent in terms of the numbers of occurrence or duration of each episode of grinding. The comparison of nocturnal muscle activity between difference nights also involved different placement of electrode. Therefore the Okeson's study might not be conclusive due to all these variables.

Thus, the effect of the splint on the parafunctional activity might need to be conjectured from other design of the study. For an example, it was known that the individual with bruxism would normally grind their teeth as hard at night. The dynamic grinding activity at each point of time might resemble the static maximum clenching activity. The study on the static maximum clenching activity was obviously subject to less variability as compared to the study on the nocturnal muscle activity. It is because the duration of each episode of maximum clenching could be fixed and the same electrode placement could be used, and also the study was done when the subject was awake.

For individual with parafunctional habit who clenched his teeth, although might not always at maximum level, the maximum clenching activity might probably represent the greatest activity of his clenching.

5.2. The effect of the soft splint on TMD patients after 6 weeks of conservative treatment

5.2.1. Experimental group after 6 weeks of conservative treatment

After six weeks of conservative treatment, there was no significant difference in the maximum clenching EMG activity of the masseter muscle upon insertion of the soft splint, but there was still a significant decrease in the maximum clenching EMG activity of the anterior temporal muscle. This meant that the masseter muscle now more resembled that of the healthy subjects. It was because the splint also caused no significant difference in the maximum clenching activity of the anterior temporal and masseter muscle of the healthy subjects as found in this study. Holmgren et al. (1990) (n=31) reported that after long-term (3-6 months) occlusal splint therapy and after improvement of the signs and symptoms of TMD, more patients showed no significant difference in maximum clenching activity of the anterior temporal and masseter muscle upon insertion of splint.

It appeared that some changes had happened in the masseter muscle, while there were no or less changes in the anterior temporal muscle, after 6 weeks of conservative treatment. It was suggested that recovered muscle might be less sensitive to the vertical dimension changes caused by the splint, similar to that of healthy subject due to the muscle was stronger. This suggested that the masseter muscles might have recovered effectively but not the anterior temporal muscle. Treatment period of 6 weeks might be too short for effective recovery of the anterior temporal muscles. As in the literature review of this study (section 2.9.4.), temporal muscle play an important role in both of the postural and clenching activity, while masseter muscle contribute more to clenching activity only. In other words, the temporal muscle was active most of the time but the masseter muscle was active during forceful activity (Naeije et al., 1989). Therefore the anterior temporal muscle might take longer time to recover effectively to resemble that of the healthy subjects.

On the other hand, the reason that the clenching EMG activity of anterior temporal muscle was still decrease by the splint after conservative treatment, may also be due to the more responsive tendency in anterior temporal muscle as found in the literature review of this study (Ramfjord & Ash, 1995; Al-Quran & Lyons, 1999).

5.2.2. TMD patients with resolved and unresolved pain after six weeks of conservative treatment

After 6 weeks of conservative treatment, patients with resolved pain generally showed no significant difference in the postural and maximum clenching activity of the anterior temporal and masseter muscles, before and after insertion of the splint. Similarly, patients with unresolved pain also have no significant difference in the postural and maximum clenching activity of the anterior temporal and masseter muscles, before and after insertion of the splint. It appeared that there was no distinct difference between these two subgroups. Thus, no conclusion could be drawn to address whether the patients with resolved pain really resembled the healthy subjects in terms of their response towards the splint.

The sample size for the subjects with unresolved pain (n=5) was too small for reasonable interpretation. This group failed to respond to the conservative treatment including splint therapy but the reason behind was unable to be revealed from such analysis.

Therefore, the attempt of analysis by dividing the experimental group into these two subgroups might not be appropriate in this study as the statistical power of each subgroup had become smaller.

5.2.3. TMD patients with resolved and unresolved pain before conservative treatment

Before the conservative treatment, patients with unresolved pain generally showed no significant difference in the postural and maximum clenching activity of the anterior temporal and masseter muscles, before and after insertion of the splint. Similarly, patients with unresolved pain also have no significant difference in the postural and maximum clenching activity of the anterior temporal and masseter muscles, before and after insertion of the splint.

It was found that before the 6 weeks of conservative treatment, the EMG analysis result for TMD patients with resolved pain was much different from that of the experimental group. Since TMD patients with resolved pain represent the majority (72.2%) of the experimental group, it implied that reduced sample size from 18 to 13 would greatly affect the results of the analysis of significant difference.

The EMG result for the subjects with resolved pain after 6 weeks of conservative treatment compared to that of before the conservative treatment did not show much difference. Therefore no conclusion could be drawn to address whether there was a real progressive change in these two subgroups respectively.

5.3.1. Signs and symptoms before and after conservative treatment

5.3.1.1. Muscle pain

In this study, 77.8% of the subjects complained of having masticatory muscle pain. About one third of them presented with bilateral pain, while the remaining two thirds had unilateral muscle pain that affected either the right or left side.

In this study, more patients with muscle pain were recruited compared to patients with joint pain. However due to the sample size was very small, no conjecture on the prevalence of muscle and joint pain from Malaysian population could be made. Solberg (1987) had reviewed 14 epidemiological studies and found that masticatory muscle tenderness was a more common finding than TMJ tenderness. In his review, the prevalence of masticatory muscle tenderness ranged from 13 to 66 %, while TMJ tenderness ranged from 1 to 45%. It was suggested that functional overloading would either first affect the normal functional activity of the masticatory muscle before the joint, or the joint structures have higher capacity in withstanding functional overloading to cause dysfunction to the patient.

After six weeks of conservative treatment, of the 14 subjects who complained of masticatory muscle pain, 78.6% of them regained their usual function without pain while 21.4% had pain on function. Of those who regained their usual function without pain, half of them still had minor pain when attempting maximum mouth-opening.

5.3.1.2. Joint pain

In this study, 55.6% of the sample group complained of TMJ pain. Most had unilateral joint pain, with the left side being affected more frequently than the right. Only one fifth of them had bilateral joint pain. Unilateral chewing function has been shown to be more common in symptomatic patients (Frank, 1968). Its association with the major unilateral joint involvement in this study is unclear. Whether unilateral chewing had a role to play in the unilateral joint pain or not as observed in this study was unclear.

After conservative treatment, of the 10 subjects who complained of TMJ pain, 70% of them regained their usual oral function without pain while 30.0% still had pain on routine oral functioning.

5.3.1.3. Muscle and joint pain

In this study, one third of the TMD patients were having both muscle and joint pain. It was suggests that many of the TMD patients would have disorders of the masticatory muscles as well as the TMJ. They may share some of the etiological factors.

After conservative treatment, 72.2% of the sample group had resumed their usual function without muscle and/or joint pain, while the remaining 27.8% still present with pain on routine oral functioning.

5.3.1.4. Joint click

In this study, 13 (72.2%) subjects had TMJ click during movement, where 5 (27.8%) of them had single side clicking and 8 (44.4%) both.

Previous reviews of epidemiological studies (Solberg, 1987; Okeson, 1998) showed that an average of 58% of the studied population had at least one clinical sign of TMD, and TMJ sounds were detected in 25% to 35% of the studied population. This implies that TMJ sounds comprised about half of the clinical signs.

In this study, of the 13 subjects who originally presented with TMJ click during movement, only one subject had no more click while the remaining 12 subjects (92%) still had click, after conservative treatment.

Randolph et al. (1990) (n=110) also reported that TMJ noises were the symptoms that are most resistant to treatment. In their study, out of the 64 patients who originally presented with TMJ clicking, 14% reported absent of click, 42% reported improvement of joint sounds, 37 % reported that the sounds remained unchanged, and 7% reported that the joint sounds condition had worsened, after conservative treatment.

5.3.1.5. Limitation of mouth-opening

In this study, half of the sample presented with limitation of mouth-opening. Limitation of mouth-opening was a common dysfunction that was associated with TMD. The common cause was pain in the masticatory structure. Obstruction in the joint could also cause limitation of mouth-opening.

The cut-off values set in RDC/TMD for limited mouth-opening that due to muscle disorders and disc displacement were different which are 40 mm and 35 mm respectively. This research criterion however might not represent the dysfunction stage experienced by the patients. Individuals might need to have an interincisal opening of less than 30 mm to encounter many dietary or functional restrictions, as defined by the American Association of Oral and Maxillofacial Surgery (Zeitler & Porter, 1993).

After conservative treatment, of the 9 subjects who had limitation of mouth-opening, 44.4% subsided while the remaining 55.6% still had limitation of mouth-opening.

5.3.1.6. Limitation of lateral mandible movement

In this study, 55.6% subjects exhibited limitation of lateral mandible movement. This form of limitation was usually due to the obstruction in the joint.

After conservative treatment, of the 10 subjects who exhibited limitation of lateral mandible movement, only one subject showed resolution, while the remaining 9 (90.0%) still had limitation of lateral mandible movement.

5.3.1.7. Mandible deviation during mouth-opening

In this study, 77.8% of the subjects exhibited mandible deviation during mouth-opening, and transient deviation was more prevalent than lasting deviation. Deviation of mouth-opening was usually the result of joint obstruction.

After conservative treatment, of the 14 subjects who exhibited mandible deviation during mouth-opening, none of them showed resolution.

5.3.2. Conservative treatments

Generally, in management of TMD, none of the treatment can be carried out solely to treat the disorders successfully without patient education and self-care. Therefore it was sometime inappropriate to isolate certain form of treatment in assessment of its effectiveness because it might doom to failure. In this study, the effectiveness of the soft splint was assessed in combination with other basic conservative treatment included patient education and self-care, and analgesic; however without controls. The analgesic was advised only to be used in acute unbearable pain situation. Patient education and self care mostly consisted of dietary advice and self-control of parafunctional habits or adverse usage of masticatory system. Patient education and self care are considered one of the most important parts in the conservative treatment. Treatment modality should be aimed more towards curative rather than just symptomatic relief as provided by most pharmacological intervention.

5.3.2.1. Assessing effectiveness of conservative treatments

In this study, conservative treatment seemed to be a useful approach in treatment of TMD patients. However, to study the effectiveness of conservative treatment more conclusively, there should be a control group consisted of TMD patients without the conservative treatments versus the experimental group. The recruitment of such control group was not done because it was beyond the scope of this study.

In this study, 72.2% of the patients had experience resumption of their routine oral function without pain, although about half of them still had slight pain in achieving maximum mouth-opening. It was still reasonable to assume that these patients showed sufficient resolution of the TMD symptoms of pain, since maximum mouth-opening was not usually needed in normal function or in daily life. The need and goal of the patient should be the most important factor in determining the success of the treatment. Usually the main concern of the patients is pain and difficulty in undergoing their routine oral function. The total resolution of all the symptoms of TMD become unrealistic or impractical while ignoring the patient's needs. This was in line with the report by Randolph et al. (1990), that the pain and dysfunction of TMD were difficult to be measured quantitatively; therefore the clinician's assessment of posttreatment physical findings is less important than the TMD patient's subjective report on the treatment outcome. It appeared in this study that signs included clicking, limitation of lateral mandible movement and mandibular deviation during mouth-opening, were quite resistant to conservative treatment. It was suggested that the patients that had resumed their routine oral function without pain might be contented with such treatment outcome since normally one of their main reasons to seek treatment was pain in performing the routine oral function. However in this study, patients were not measured for their satisfaction towards the treatment outcome.

The goal of achieving normal repositioning of the disc for every case may not be practical because clicking itself usually do not cause dysfunction to the patient. Previous epidemiological data reported that about a quarter of the general population had clicking TMJ (Solberg, 1987). This differs from the percentage of population that seek TMD treatment which is less than 10%. Besides, the most common patient complaint in dental practice is pain. Clicking is indeed only the most common sign found by clinician. In many patients with disc displacement, painless jaw function is still possible.

In this study, conservative treatments that comprised of patient education and self-care, analgesics and soft splint seems to reduce the symptoms of limitation of mouth-opening that was due to pain rather than that was due to disc displacement. Apparently the conservative treatments did not really reduce the click effectively.

5.3.2.2. Effectiveness of conservative treatments

In this study, the effectiveness of conservative treatments that comprised patient education and self-care, analgesics and soft splint, in resolving the pain of the TMD patients to resume their routine oral function was 72.2 %.

Okeson (1998) had reviewed 30 long-term studies that can give the most accurate information regarding effectiveness of treatment. He found that conservative and nonconservative therapies seem to report similar success rates of 70% to 85% on a long-term basis. In many studies, most patients suffering TMD achieve good relief of symptoms with conservative treatment, which show 50% to 90% of the patients have few or no symptoms after conservative treatment (Okeson, 1996). It would appear therefore that a logical approach to patient management is to attempt conservative treatment first rather than nonconservative treatment.

Randolph et al. (1990) had done long-term (1 to 7.5 years) follow-up evaluations of 110 adult patients with myofascial pain and disc displacement, or both. They compared patient response to conservative therapy combined with advice about self-management, with the response to advice only. The results revealed no significant differences. At the time of the follow-up evaluation, 88% of all patients reported substantial or total improvement in their symptoms of pain and dysfunction. Therefore, conservative therapy, including advice about self-management, was found to be both adequate and appropriate for most of these patients.

The designed conservative treatments package in this study seemed to be an effective way in treating the TMD patients. However, it was rather difficult to assess internally within this study whether the resolution of pain actually happened spontaneously or consequently to conservative treatment or even due to placebo effect. The treatment outcome in this study would be the sum effect of patient education and self-care, analgesics, splints and time.

5.3.3. Patients' personal comments on the usefulness of soft splint

Only 4 (22.2%) patients had commented that the soft splint was helpful in relieving the symptoms. All 4 of these patients, was found to have their pain resolved after six weeks of conservative treatment. On the other hands, there were also 4 (22.2%) patients who commented that the splint made them felt worse. Three out of these patients was found to have their pain unresolved after six weeks of conservative treatment. Meanwhile, for 10 others that gave neutral comment towards splint therapy, 7 of them have their pain resolved after six weeks of conservative treatment but other 3 have their pain unresolved.

This preliminary observation implied that soft splint therapy might not benefit patients that gave negative comment and therefore could be excluded from the conservative treatments package.

5.3.4. Effectiveness of soft splint in reducing dysfunction

In this study, the splint therapy was given together with patient education and self-care, and analgesics. There was no another control group consisted of patients that was treated only with patient education and self-care, and analgesics. Without such control group, the effectiveness of splint alone was difficult to be accessed. Therefore, the effectiveness of soft splint in treatment of TMD could not be firmly concluded from this study. The treatment outcome in this study would be the sum effect of patient education and self-care, analgesics and time also but not soft splint per se.

In the studies by Harkins et al. (1988) (n=42), 74% of the TMD patient with clicking joint reported less in facial myalgia while 26% reported more or no change, after 10 to 20 days of soft splint therapy. Wright et al. (1995) (n=10) found in their study that 90% patients with masticatory muscle pain reported symptoms improvement after 4-11 weeks of soft splint therapy. Block et al. (1978) (n=19) also reported 74% of TMD patients had complete or almost complete symptoms remission after 6 weeks of soft splint therapy.

These 3 studies were in contrary with the study by Nevarro et al. (1985). Nevarro et al. in their study (n=10) of comparing treatment effect of hard and soft splint for 3 months, reported that only 10% of the TMD patients treated with soft splint had total remission of symptoms while 10% had partial remission, 60% had additional morning soreness and 20% had no change. However this different result might simply due to small sample size in their study.

5.4.1. Demographic distribution

Generally demographic factor of TMD patients would affect the results of the study. For better comprehension of the study's result especially when comparing the results among different studies, a data report on the demographic distribution of the experimental group was therefore needed.

5.4.1.1. Sex

In this study, women (77.8%) comprise the majority group who seek TMD treatment. The gender distribution of one study is greatly dependent on how the subjects were selected, either from common population or patient group seeking for treatment. Studies that drew subjects out of the common population would usually report of equal involvement of both genders (Helkimo, 1974a, 1974b, 1974c). In other words, TMD actually affect women and men equally in general population.

Meanwhile, the study by Howard (1991) reported that out of the all TMD patients who seek treatment, 85.4% were women. This was because of Howard (1991) recruited his subjects out of TMD patient group but not from common population as in the studies by Helkimo (1974a, 1974b, 1974c). In this study, the subjects were all selected from those patients who attended the Oral Medicine clinic of the Department of Oral Pathology, Oral Medicine and Periodontology, Faculty of Dentistry, University of Malaya, seeking for TMD treatment. This is a referred centre and also the main Oral Medicine centre in the country. According to Census 2000 Malaysia, there were 104 males for every 100 females, or the male to female ratio is 1:1. (Department of Statistics Malaysia, 2001). Despite this balanced ratio, women were predominant in seeking for TMD treatment found in the sample of this study. However it was inappropriate to draw this finding to represent the TMD patient population in Malaysia since the sample size was too small.

Usually the women predominance was attributed to their greater health awareness, which is usually also true for many others dental treatment utilization (Randolph et al., 1990).

In spite of the high ratio of women to men in TMD patient population, initial investigations did not document more symptoms in women. (Agerberg & Carlsson, 1972). Helkimo (1974c) revealed that the recorded symptoms of dysfunction were equally common among men and women, with but few exceptions. Helkimo had used a population of 321 Finnish-Lapps aged 15-65 as the basis sample for his studies.

5.4.1.2. Race

In this study, in term of the race distribution, the Malay comprised the majority (50%) while Chinese 27.8% and Indians 22.2%. According to Census 2000, of the total Malaysian citizens, Bumiputera (Malay and Non-Malay indigenous) comprised 65.1%, Chinese 26.0% and Indian 7.7%. (Department of Statistics Malaysia, 2001). The race distribution in this study was different from the national ethnic composition especially the Indian percentage was about three folds of the national ethnic distribution. However no inference on race distribution from this study could be made as the sample size was very small. The prevalence of TMD in every ethnic group had to be investigated with much larger sample size.

Lipton & Marbach (1984(a)) in their study on Black, Irish, Italian, Jewish and Puerto Rican facial pain patients, reported that the five ethnic groups were generally found to be similar in their reported responses to pain, which included symptom history, signs elicited on physical, radiographic and laboratory examination, as well as social, cultural and psychological data. This implied that the race factor might not affect greatly the result in this study. However since the above study was done on the 5 ethnic groups that were very different from Malaysians' population, the true ethnic effect on TMD in Malaysians' population awaited future local study.

5.4.1.3. Age

In this study, the mean age for all the subjects was 28.9 years old, while the mean age for female was 27.6 years and male 33.3 years. This age distribution was quite close to that of Howard (1991)'s study, where the mean ages of women and men were 34.2 and 33.8 years respectively. The epidemiological studies by Von Korff et al. (1988) and Dworkin et al. (1990) revealed that most TMD symptoms are reported among population aged 20 to 40. In this study, the TMD patients of the experimental group had a wide range of age as indicated also by the large standard deviation. The mean age for all the subcategories divided either according to sex or race, all fall well within the range of 20 to 40.

Well-defined studies by Helkimo (1974a, 1974b, 1974c) revealed that the recorded symptoms of dysfunction varied only slightly with age, with but few exceptions. Helkimo had used a population of 321 Finnish-Lapps aged 15-65 as the basis sample for his studies. A study on sample group aged 6-18 done by Mintz (1993), reported the prevalence of signs and symptoms of TMD was the same in children and adolescents as in adults. Therefore the age factor also might not influence much the result in this study.

5.4.2. Dentition characteristic

As the dentition characteristic was an important factor in contributing to the study's results, a data report on the dentition characteristic of the experimental group was also done in this study.

5.4.2.1. Incisor classification

In this study there is no predominance in patient distribution according to the incisor relationship. Subjects with Class I and Class II division 1 incisor relationship comprise one third each of the sample group while Class III 27.8%. In the review by Okeson (1998) that investigated the relationship between the signs and symptoms of TMD and occlusion, reported that some studies found that there was positive relationship between occlusion and TMD whereas others did not. Pullinger et al. (1993) reported that no single occlusal factor was able to differentiate patients from healthy subjects. However, there were four occlusal features that occurred mainly in patients with TMD, including presence of a skeletal anterior open bite, discrepancies between retruded contact position and intercuspal contact position that is greater than 2 mm, overjet of greater than 4 mm, and five or more missing posterior teeth that were not rehabilitated. These occlusal features were rare in healthy subjects. From the biomechanics viewpoint, for those who have extensive overjet, biting at the front require forward positioning of the mandible, which is less favourable for muscle acting, compare to individual with normal overjet. Among other studies that suggest positive relationship, some tried to associate TMD with Class II and III (Okeson, 1998). However, more specific occlusal characteristic such as overjet is considered more relevant than general occlusal characteristic such as an incisor relationship.

5.4.2.2. Anterior guidance

Most subjects (61.1%) in this study had group function on posterior teeth, while 27.8% had canine guidance. The predominance of group function is most probably just due to higher distribution per se, and did not contribute to the TMD. Williamson and Lundquist (1983) demonstrated that if a group function exists, both the masseter and the temporal muscles on the working side are active during a laterotrusive movement; while if canine function exists, only the temporal muscle is active during the laterotrusive movement. However other studies were unable to show evidence that support an association of occlusal guidance with TMD (Roberts et al., 1987; Pullinger et al., 1993). In this study, the association of occlusal guidance with TMD remained unknown because the control group was not examined for the entire dentition characteristic as in experimental group.

5.4.2.3. Deep overbite

In this study, only 22.2% subjects had deep overbite. Runge et al. (1989) associated extensive overbite with TMJ disorder while Seligman et al. (1988) associated extensive overbite with masticatory muscle tenderness. However, most studies do not support these associations (Riolo et al., 1987; Roberts et al., 1987; Pullinger et al., 1993).

5.4.2.4. Deviated occlusal plane

In this study, 16.7% subjects had deviated occlusal plane. These patients had gross malocclusion with slanted occlusal plane and cross bite, together with asymmetrical jaw size. All these patients had occlusal interference upon mandibular movement. Okeson (1998) stated that when a patient presents an occlusal position that is neither optimal nor normal, the tendency is to assume that it is the major contributing factor. However the extend of this logical assumption still await further study. Occlusal disharmony is potentially damaging to disc contour as well as to the temporal and condylar articular surfaces. Occlusal disharmony is a static positional disharmony that asserts the effect mainly when the teeth are firmly clenched (Bell, 1990).

5.4.2.5. Crowding

In this study, 16.7% subjects had moderate to severe crowding. Gross crowding may not be significant by itself in contributing to TMD (Okeson, 1998). It was also noted that these subjects had occlusal interference during mandibular movement, which is considered more relevant to contribute to TMD (Egermark-Eriksson et al., 1987).

5.4.2.6. Interference on lateral excursion

In this study, 72.2% of the subjects had non-working side interference on lateral excursion. Compare to ideal occlusion with optimum teeth contact, chewing efficiency was usually compromised in malocclusion. Reduced chewing efficiency may need supplement through higher muscle activity that could lead to muscle fatigue. Bell (1990) discussed that occlusal interference that occur prior to maximum intercuspal position did not particularly damage the articular surfaces or joint ligaments. Such interference had its effect primarily on the muscle and the teeth. Occlusal interference served primarily as a predisposing factor that required activation before it became etiologically important. Functional overloading such as bruxism or overloading due to emotional tension played an important role as precipitating factors.

5.4.3. Parafunctional habits and adverse usage of masticatory system

Although having parafunctional habit was not an inclusion criterion in this study, it was found that all the patients had at least one form of parafunctional habits. Meanwhile, about two third of the patients also reported of adverse usage of the masticatory system. This implies that functional overloading might be an important etiological factor in TMD. The parafunctional habits and the adverse usage of masticatory system needed to be revealed through careful examination and history taking. It was suggested that treatment of TMD might need to involve reduction of functional overloading that was caused by parafunctional habits and adverse usage of masticatory system, priority to those with prolonged duration or with high magnitude of force. Since soft splint could reduce the muscle activity, it was suggested that TMD patients presented with functional overloading such as clenching might be beneficial of soft splint treatment.

However this finding was inconclusive because it was without controls, as the control group was not examined for the presence of functional overloading.

5.4.3.1. Parafunctional habits

All the patients had either clenching or/and grinding habits (100%). There were 61.1% of them having clenching habit and grinding 77.8%. Chung et al. (2000) (n=26) in their uncontrolled study reported that the prevalence of nocturnal bruxism was 88%. Sirirungrojying and Kerdpon (1999) reported in their study that the prevalence of bruxism in TMD patients (n=59) was 54.2%, which was higher than the controls (n=353), 24.7%; while Velly et al., (2002) reported in their study that the prevalence of bruxism in TMD patients (n=59) was 57.6%, which was higher than the controls (n=99), 43.4%. The result in this study seemed to support that bruxism was an important contributing factor in TMD. However this result needs further evaluation by future study with controls and with larger sample size.

In this study, 66.7% of the patients had the habits of resting the jaw on the hand. Yamada et al., (2001) (n=94) in their study on TMJ disorders patients, reported that the prevalence of the habit of resting the jaw on the hand was 43.6%, which was also very high. Generally, patients might not be aware of the adverse effect of the habits of resting the jaw on the hand. However damaging effect was created through its prolonged duration. In this study, 44.4 % of the patients had parafunctional habit of object biting. Patients might either bite on some part of their own body such as lips and fingernail, or on some foreign body such as pen and tooth-pick. Yamada et al., (2001) reported that the prevalence of tongue or lip biting was 23.4% in their study.

5.4.3.2. Adverse usage

In this study, 66.7% of the patients had adverse usage of the masticatory system. All these patients had preference in taking hard diet. The damaging effect was exerted mainly through its high magnitude of force. In this study, 22.2 % of the patients liked gum chewing. Yamada et al., (2001) in their study, reported that the prevalence of gum chewing in TMJ disorders patients (n=94) was 31.9%, which was suggestive of the possible etiologic cause for TMD. In this study, 22.2% of the patients had poor sleeping posture that was sleeping on the stomach. 16.7% of the patients frequently yawned widely. One patient (5.6%) had task-related adverse usage that she often played tuba. All these adverse usages could cause damage to the masticatory system especially through prolonged duration. However this awaits further evaluation by future study with controls and with larger sample size.

5.5. Limitation of this study

This was a short term study which was carried out in one single centre. The sample size was small and also without randomization. Therefore, it was not representative of the TMD population. This was one of the major drawbacks in this study. Ideally much larger sample size should be recruited. This could be achieved by lengthening the research time frame or with multi-centre study design. The use of larger sample size would increase the statistical power and render the study result more confirmative.

There was no inter-investigator or intra-investigator calibration to monitor for investigator variability. The investigator variability would affect the EMG study's result greatly especially if the study was designed to compare directly the EMG activities between subjects. In this study, the EMG activities were compared indirectly that was to assess for significant difference after insertion of splint. Therefore the effect of investigator variability was relatively less. However for superior study, calibration should best be carried out.

In this study the TMD patients were not divided into more specific subtypes and patients with myofascial pain and arthralgia with disc displacement were pooled together as one experimental group. EMG activity of patients and the response towards the splint for the patients with muscle pain may be different from those with joint conditions. Besides, the age range for the patients was also quite broad. These factors may account for the large standard deviations reported in this study. Ideally, TMD patients' selection should be of specific TMD subtypes and with narrow range of age.

It was noted in this study that the EMG activity varied widely between subjects. The wide variation in the EMG activity existed between subjects was reflected by relatively large standard deviations as reported in this study. More stringent inclusion criteria in patients' selection could normally reduce the variation such as patients' selection of specific TMD subtype and from narrowed range of age group. Detailed consideration of each TMD subtype should be done too. For an example, patient recruitment with masticatory muscle disorders should take considerations of severity of muscle pain, numbers of muscle sites involved, bilateral or unilateral involvement, single muscle type or multiple muscle type involvement. Boldly comparison for patients within each TMD subtype without such considerations would render the effort to minimize the variation to be unfruitful. More stringent criteria will be needed in future study to allow more confirmative conclusion. Study on TMD patient should be focused on more specific TMD subgroup.

Since the masticatory muscles and TMJ were in pairs, study might even need to be specified to one side only. For an example, patients should complain only of muscle pain, that involve only the masseter muscle, and only one side of muscle is in pain and the pain is on the same side. The EMG test and the analysis of EMG readings should all be specific to painful side or painless side. However, subdividing the patients in such a way will affect the sample size and then the statistical power. Therefore a lot more subjects have to be recruited for this kind of highly specified study.

Generally EMG study inherited with variation in data recording. Variation due to EMG measurement may be able to be reduced through more meticulous control on measurement procedure especially in electrode placement.